

Western Sydney University Indigenous Centre of Excellence Flood Impact Risk Assessment

Western Sydney University

December 2025

Rev M

Western Sydney University
Indigenous Centre of Excellence
Flood Impact Risk Assessment

Project	Western Sydney University, Indigenous Centre of Excellence – Flood Impact Assessment
Report Includes:	Flood Impact Risk Assessment Flood Emergency Response Plan Riparian Zone Management Assessment
Client	Western Sydney University
Job No.	230076

GRC Hydro Pty Ltd	Level 20, 66 Goulburn St, Sydney, NSW, 2000 ABN: 71 617 368 331
Project Author	Mat Faint
Reviewer	Stephen Gray
Version	M
Date	11 December 2025

DISCLAIMER:
This document is produced by GRC Hydro solely for the benefit and use by the client in accordance with the terms of the engagement. GRC Hydro does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

1. Table of Contents

1. Table of Contents 3
2. Executive Summary 5
2.1 Response to Request for Information 5
3. Introduction 24
3.1 Site Location and Description 24
4 Project Description 24
4.1 Topographic Context 25
4.2 Project Scope 26
5 The Site's Flood Liability 27
6 Flood Modelling 29
6.1 Hydrological Model 29
6.1.1 Rainfall Losses 30
6.1.2 Lag Parameter 31
6.1.3 Imperviousness 31
6.1.4 Temporal Patterns and Critical Duration Assessment 31
6.1.5 Unit Flow Rate Comparison 32
6.2 Hydraulics 33
6.2.1 Topography 33
6.2.2 Material Roughness 33
6.2.3 Structures 35
6.2.4 Victoria Road Bridge Deck 36
6.2.5 Parramatta Light Rail Bridge 37
6.2.6 Stormwater Network 38
6.2.7 Upstream Flow Boundary 38
6.2.8 Tailwater 39
6.2.9 Climate Change 39
6.2.10 TUFLOW Model Setup 41
6.3 Model Results and Verification 42
6.3.1 Existing Condition 42
6.3.2 Comparison of Modelled Existing Levels to Council Flood Levels 64
6.3.3 Flood Planning Level 64
6.3.4 Proposed Development 65
6.3.5 Proposed Condition 66
6.3.6 Flood Level Impact 66

6.3.7 Cumulative Impact Associated with Car Park Development 66
6.3.8 Comparison of Pre-Development and Post Development Flows 67
7 Flood Emergency Response Plan 98
7.1 Emergency Response Summary 98
7.2 Flood Emergency Context 98
7.3 Parramatta River Flooding 99
7.4 Flood Risk Assessment 100
7.5 Emergency Management Approach 105
7.5.1 Preparation 106
7.5.2 Warning Systems 108
7.5.3 Ensuring the Campus is Empty when Severe Weather is Predicted 109
7.5.4 Emergency Access for Secondary Medical Events 109
7.5.5 Shelter-in-Place (a Back-Up Strategy) 111
7.6 Going Upstairs to Level One to Shelter-in-Place Refuge Area 111
7.6.1 Continuous Improvement 112
7.7 Emergency Procedure 112
7.8 Flood Emergency Drills 113
7.9 Engagement with the State Emergency Service 115
7.10 Emergency Response – Car Park 115
8 Compliance with Flood-Related Planning Controls 117
8.1 Planning Control Compliance Requirements 117
8.1.1 Parramatta Development Control Plan (2023) 118
8.1.2 Parramatta Local Environmental Plan (2023) 123
8.2 Addressing Government Guidance 124
8.2.1 Shelter-in-Place Guidelines for Flash Flooding 124
8.2.2 Flood Risk Management: Understanding Flood Behaviour (FB01) 130
8.2.3 Support for Emergency Management Planning Support (EM01) 132
8.2.4 Addressing the goals of the NSW State Flood Plan 134
9 Riparian Zone Management Assessment 136
10 Summary 138
Appendix A: Council Flood Certificate 139
Appendix B: ICoE Architectural Drawings 144
Appendix C: Consideration of the Flood Risk Management Manual (2023) 153

2. Executive Summary

An Indigenous Centre of Excellence (ICoE) is proposed to be developed in the north-eastern corner of Western Sydney University's (WSU) Parramatta South campus.

A flood impact risk assessment (FIRA) has been undertaken for the site and the proposed development. The flood behaviour has been modelled – according to Australian Rainfall and Runoff guidance – in both this existing and proposed scenario and compliance has been demonstrated with local planning guidance including the Parramatta Local Environmental Plan (LEP) (2023), the Parramatta Development Control Plan (DCP) (2023).

GRC Hydro's (GRC) reporting has undergone a series of review rounds to address responses from a variety of agencies. This newly updated report (Rev M) addresses the latest round of agency comments and GRC's modelling and reporting has been updated accordingly.

This updated report documents modelling for an on-slab development surrounded by landscaping works and also incorporates the proposed car park development to the south and south-west of the proposed ICoE footprint. This updated design remains consistent, and compliant with the flood-related controls and objectives of local planning instruments.

Additionally, GRC has accepted agency guidance on the preference for evacuation and has amended the Flood Emergency Response Plan (FERP) to include provision for an early evacuation trigger based on if a BoM severe weather (rainfall) or severe thunderstorm warning is issued, and the estimated daily rainfall exceeds 100 mm. These warnings will also trigger an email/text request that would-be occupants (students, staff or guests) should stay away from the site if flooding is predicted. Shelter-in-Place has been retained as a residual safety measure in the event that some occupants find themselves at the site if flash flooding occurs after they've been advised to evacuate.

2.1 Response to Request for Information

In this latest iteration of agency comments, responses or requests for information have been issued by the following agencies:

- The City of Parramatta (Council) (7 October 2025)
- NSW State Emergency Service (SES) (7 October 2025)
- Conservation Programs, Heritage and Regulation (CPHR) Group of the NSW Department of the Climate Change, Energy, the Environment and Water (14 October 2025)

The flood-related requests have been collated in the table below along with GRC's responses.

Table 1: Responses to Agency Comments

Agency	Request	GRC Response
NSW SES	• NSW SES recommends providing adequate flood risk management measures that avoid reliance on a FERP; ensure people do not enter high hazard flood areas, noting significant depths adjacent to the building in a 1% AEP event.	A FERP is required documentation for this project. FERPs help laypeople understand how best to respond to residual flood risks at the site. (Residual flood risks are rare risks that can remain even after efforts have been made to improve the flood safety of a development by design.) The FERP has been simplified to adopt an early evacuation approach with a back-up Shelter-in-Place strategy. This approach clearly and simply directs occupants to stay inside and move upstairs when flash flooding is rising in the development's landscapes forecourt (to the south-east of the building). Occupants will be above the PMF level after only taking a few steps up the stairwell (1.4 m in height above the 9 mAHD ground floor). As part of the updated FERP, a PA message will tell occupants to move away from the forecourt. WSU staff will ensure this area is cleared. Following evacuation of this area, doors connecting with the forecourt will be automatically locked by flood wardens when flooding first appears in the forecourt.
NSW SES	Change FERP/FIRA triggers to Severe Weather/Thunderstorm Warnings; remove reliance on on-site flood markers and 'evacuation orders' terminology; resolve contradictions between sections 7.4.2.2 and 7.4.2.3.	The emergency response has been simplified to have a very conservative, early evacuation trigger with a back-up shelter-in-place procedure.
NSW SES	Clarify how emergency supplies and services (power and water) will be assured; incorporate lift safety features; remove 'evacuate in place'; add 000 and 132 500 contact guidance; avoid placing flood wardens in danger.	Emergency supplies will be kept on site on level one as a matter of standard operation. Power and water backup can be confirmed in detailed design through a condition of consent. Lifts will be parked and become non-operational as flooding begins to impact the development. Contact numbers have been added to contact guidance.
NSW SES	Incorporate climate change guidance (ARR updates, Climate Change Calculator) reflecting increased frequency of events; update risk assessment and mitigation.	Flood modelling has been updated as per this request.

Agency	Request	GRC Response
NSW SES	Clarify how the site will ensure people do not enter high hazard flood areas given 1% AEP depths up to 1 m immediately adjacent to the building (greater with climate change).	As part of the updated FERP, a PA message will tell occupants to move away from the forecourt. WSU staff will ensure this area is cleared. Following evacuation of this area, doors connecting with the forecourt will be automatically locked by flood wardens when flooding first appears in the forecourt.

SES	Principle 1 Any proposed Emergency Management strategy should be compatible with any existing community Emergency Management strategy. Any proposed Emergency Management strategy for an area should be compatible with the strategies identified in the NSW State Flood Plan and the Parramatta LGA Flood Emergency Sub plan, where evacuation is the preferred emergency management strategy for people impacted by flooding.	Alignment with the the NSW State Flood Plan's Goals have been demonstrated in the updated FERP. WSU will use Severe Weather Warnings and Severe Thunderstorm Warnings as well as BOM's rainfall estimates (>100mm) as an early trigger to tell occupants to go home or stay away from the site. As a backup, being cognisant that human behaviour may mean that some people insist on coming to, or remaining at the campus, a shelter-in-place is retained as a back-up option at this site given the quick rate of rise and quick duration.
	Additionally, we • Reiterate our recommendation to reduce the reliance on flood wardens and human behaviour to initiate emergency procedures. The FERP continues to state "Flood wardens will observe the on-site flood markers at very regular intervals" and that emergency procedures will commence when markers reach 7.8 mAHD, however as the PMF rate of rise shows flooding reaches flood level in a matter of minutes this is not a reliable trigger.	The FERP has been updated to include two sump alarms (one at the 5% AEP level and one 0.2 m higher than the 5% AEP level) to automatically trigger an alarm and PA message that tells all occupants to immediately move to level one. Having two alarms provides contingency. Both are to be fitted with back-up batteries or generators.
	• Recommend changing the evacuation and dissuasion triggers in the FIRA to be based on Severe Weather Warnings and Severe Thunderstorm Warnings. We also recommend understanding the likely warning time available from the FloodSmart system as this may not provide adequate warning time for safe evacuation of the site.	Severe Weather Warnings and Severe Thunderstorm Warnings, and the BoM estimated daily rainfall exceeding 100 mm have been adopted as the primary trigger to encourage people to stay home and not come into the ICoE. WSU already adopts a similar system where texts and emails are sent to ask people to stay home when extreme weather is predicted.
	• "On site flood markers" are also not considered to be suitable alternatives to Severe Weather Warnings for action triggers.	Severe Weather Warnings and the BoM estimated daily rainfall exceeding 100 mm have been adopted as a trigger. On-site flood markers have been replaced with two water level alarms to trigger immediate vertical evacuation.
	• Request further details regarding how the following statement would be achieved: "Emergency supplies and services (power and water) will be assured by design and through operation and maintenance.". The risks of water and electricity mixing if the building becomes permeated by floodwater should also be considered.	The proposed development has been revised to not rely on back-up power given the potential period of isolation is less than a few hours.
	• Reiterate our recommendation for consideration of safety features for any proposed lifts, to ensure that floodwater does not enter the lift and ensure people do not exit into flooded areas.	The lifts will be parked on level one when a flooding emergency occurs to ensure that floodwater does not enter the lift and ensure people do not exit into flooded areas.

Agency	Request	GRC Response
	• Recommend removing the statement “evacuate in place” from the Flood Impact and Risk Assessment (FIRA) and anywhere else this appears, as this messaging is confusing and unclear.	Done
	• Recommend adding to Section 7.4 of the FIRA to contact 000 in all life-threatening emergencies. SES’s number (132 500) should be used for flood, storm and tsunami assistance in non-life-threatening circumstances.	Done
	• Request that references to “evacuation orders” are removed, such as on pages 85, 91 and 92 of the FIRA. The Australian Warning System uses three categories of hazard warnings: Advice, Watch and Act, and Emergency Warning. These categories replace the previous terminology.	Done. An early evacuation trigger has been adopted based on severe weather warnings and the BoM estimated daily rainfall exceeding 100 mm. When this is triggered, occupants will be directed to “Act Now” by either leaving the site or staying away.
	• Note that regarding Section 7.7 “Engagement with the State Emergency Service”, the NSW SES Emergency Risk Assessment team are the appropriate team for providing advice on the FERP, and our team provided written advice on the FERP for this site on 10 July 2024. We also highlighted at this time that: o Shelter in place' is not an endorsed flood management strategy by the NSW SES. o NSW SES further advises the development of a FERP should not be used to justify an increase in the population exposed to high hazard flooding. o This proposal… would not only place site users at risk but also pose a risk to the structural integrity of the building, as building piers would be exposed to this high hazard floodwater. The Flood Impact Assessment States “little warning time is available to safely administer an evacuation process.”	The comment quoted left is regarding an outdated design. Piers are no longer included in the design. Shelter in Place is now a backup approach. The assumption is that all people follow the early evacuation order (stay home or leave the site immediately) which is intended to ensure an empty site when flooding occurs. The NSW DPHI released Shelter-in-Place Guidelines for Flash Flooding in early 2025. These guidelines have been developed because Government has identified that there is a place for Shelter-in-Place approaches to be used in order to reduce the exposure of communities to flash flooding by providing an alternative to hazardous and uninformed evacuation attempts by the layperson. The proposed development has been designed to be structurally sound in the most extreme flooding event. Dwellings in the vicinity of the site are subject to H5 flooding in a PMF with no shelter-in-place capability. The proposed site’s design and emergency approach is by contrast, designed with full understanding of the flood risk and provides a back-up emergency response that is safe and reduces emergency burden on the SES or other emergency services.

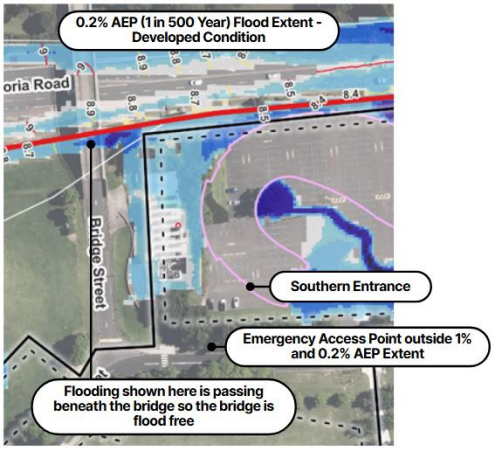
SES	*Overreliance on the FERP* As stated above, we do not agree with the report's assumption that a PMF flood event would have "minor consequences" and "low risk" to life. The plan currently relies entirely on the FERP being executed without error, including:persons on site identifying the risk or receiving warnings we note that relying on individuals to "observe flooding" is not suitable for various reasons	A FERP has been required to accompany the proposal for this site. Mitigation of flood risks have been incorporated in the building's design. The building remains flood-free and connected to an emergency services access point even in a 1 in 500 year flood. A FERP exists to further strengthen the safety of the site by informing laypeople how they must act in order to secure their own safety if flooding occurs at the site. If the site did not have a FERP, occupants at the site that remain against the advice of earlier warnings would be uncertain on how best to protect their safety and the safety of others in a flood emergency. The assessment that a PMF event is a low risk to life is based on the following: • A FERP has been developed that filters out the number of people on site by asking people to stay home if a severe weather warning is issued and the BoM estimated daily rainfall exceeds 100 mm. The remaining people will get an alarm that directs them to immediately move to the first floor once a 5% AEP flood level is reached. Moving up out of the flood hazard zone is not onerous. Walking up a few steps will elevate an evacuee 1.3 m above the ground floor. This can be achieved in a matter of seconds. • The ground floor incorporates ample freeboard even in a 0.2% AEP (1 in 500 year event) where there is 0.4 m freeboard above the flood level. The only modelled event where the ground floor is overtopped is the PMF which has a likelihood of occurrence approximate to 1 in 1,000,000 years. Likelihood of an event (in this case 1 in 1,000,000 years) has been factored into the risk assessment and influences its assessment as low risk.
	• relying on email/text alerts assumes continuous availability of internet access and/or phone signal, which may not always be guaranteed during severe storm events.	An email or text alert will be sent when a severe weather warning is issued and the BoM estimated daily rainfall exceeds 100 mm. This will be well in advance of the event actually occurring.
	• timely provision of warnings and actions for users of the site. This includes assuming all warnings and communications equipment being fully operational, no power outages to the voiceover equipment or speakers,	The warning system will be connected to an elevated backup battery/generator to ensure it can operate during an emergency.

Agency	Request	GRC Response
	• all persons being able to hear the messaging (i.e. not deaf/hard of hearing nor wearing noise-cancelling headphones, etc), and all persons heeding the messaging and acting in a timely manner.	Flashing lights will turn on and alert anyone who's deaf/hard of hearing nor wearing noise-cancelling headphones. Flood wardens will seek out confused people during a shelter-in-place trigger to help them move upstairs.
	• Even if people could be warned in time, we note that the FIRA states the mitigation strategy relies on the idea of "forcing occupants out of harms way". However, we note the plan relies on human behaviour, which cannot be relied upon due to the unpredictable nature of individuals.	Unfortunately, human behaviour is an unavoidable element of any emergency action. In an effort to eliminate the impacts of human behaviour during a flood event, the building's design has elevated the ground floor in such a way that people are safely protected from flooding in a 1 in 500 year flood event with 0.4 m of freeboard provided even in this very rare event.
	• sufficient mobility of all persons onsite to access an upper level. Due to the timing of this happening within a few minutes, people may need to self-evacuate upstairs, and lifts cannot be assumed due to risks of power failure or flooding of lift wells.	When a flood alarm sounds, disabled people and elderly people will be prioritized for lift usage. Lifts will continue to run for 8 minutes following the trigger and then lifts will be parked on level one above the PMF level at this point. This 8 minute trigger is based on the worst possible scenario where a PMF could rise from the 5% AEP level to the ground floor in approximately 15 minutes. For context, the PMF event has a probability of approximately 1 in 1,000,000 years and the ground floor remains at least 0.4 m above the flood level in a 1 in 500 year event. Flood wardens will assist people with mobility issues up the stairs if the situation demands. This will be the adopted approach if lifts stop working during the 8 minute period.

Agency	Request	GRC Response
SES	Due to the nature of flash flooding on the site, should a PMF event occur, all of these steps would need to be executed perfectly within the space of a few minutes. We reiterate our previous advice that a FERP is not a failsafe way of managing an underlying flood risk, and highlight that the risk of "catastrophic consequences… to human life" is not considered to have been sufficiently mitigated for this site.	The early trigger hopes to avoid any people being present at the site. The shelter in place strategy is retained only in the event that some people refuse to follow this advice. The building has been designed so that it is flood safe for occupants in a 1 in 500 year event. It incorporates a floor that is well-elevated above the PMF flood level and this can be accessed via one of the many stairwells in minutes. No failsafe risk management strategy exists when human behaviour is involved but the risk mitigation by design and the emergency guidance incorporated in this development's design and operation provides a sound framework to manage risks (as risk can never be fully eliminated) and keep people safe, indoors, elevated and protected from floodwaters.
SES	*Overreliance on flood wardens* The FERP states that "Flood wardens should survey the ground floor to help occupants make their way to floor one and should conduct a check to make sure all occupants have vacated the ground floor". This could place the flood wardens in potentially life-threatening danger, particularly due to the potential rate of rise of the floodwater.	Flood wardens are no longer required to serve this function.

Agency	Request	GRC Response
SES	Principle 2 Decisions should be informed by understanding the full range of risks to the community.	
	Decisions relating to future development should be risk-based and ensure Emergency Management risks to the community of the full range of floods are effectively understood and managed.	The building's design has incorporated flood risk mitigation in its design with compliant floor levels that remain well-elevated above the 1 in 500 year level and has been designed to be structurally sound in the rarest event – the PMF.
	Further, risk assessment should consider the full range of flooding, including events up to the PMF and not focus only on the 1% AEP flood. As the height of a flood event will not be known until after the flood event, risks should be considered up to and including the PMF. We note the hydrograph provided in the FIRA highlights the rapid rise of floodwater to become above floor level within approximately 10 minutes from the start of the floodwater rising.	The risk assessment has included a range of flood events including the PMF event. The revised flood response has been based on the assumption that any flood trigger could be a PMF event and therefore alerts demand immediate action as soon as flood levels reach the 1 in 20 year flood level.
	Additionally, the hydrograph on page 80 of the FIRA indicates that based on a Marsden Weir PMF, the flooding in the building would completely inundate the entire ground floor and reach the first floor level in a PMF event, therefore reaching depths of 4.35m above ground floor, which is H6 hazard and all buildings exposed to this hazard are considered vulnerable to failure.	Marsden Weir is located 2.4 km upstream of Vineyard Creek and has a higher elevation and flood level to the subject site. The PMF flood level at that location is not relevant to the site. The hydrographs at Marsden and Charles St weirs have been used solely to get an understanding of riverine flood behaviour on Parramatta River during a PMF in terms of rate-of-rise and duration.
	We reiterate that NSW SES has previously responded to flooding incidents in the area of the university campus including road inundation.	The area's flood risk is understood by the Applicant and design mitigation and flood emergency response has been developed in order to reduce the burden on the SES. Shelter-in-Place (as supported by DPHI for areas subject to flash flooding) has been adopted at this site so that occupants don't go into the roadway during a flood event.

Agency	Request	GRC Response
SES	Principle 3 Development of the floodplain does not impact on the ability of the existing community to safely and effectively respond to a flood.	
	The ability of the existing community to effectively respond (including self-evacuating) within the available timeframe on available infrastructure is to be maintained. It is not to be impacted on by the cumulative impact of new development.	The adoption of an early warning approach with a shelter-in-place approach for backup, reduces the need for the SES and emergency services to assist evacuation attempts at this site.
	Risk assessment should have regard to flood warning and evacuation demand on existing and future access/egress routes. Consideration should also be given to the impacts of localised flooding on evacuation routes. Evacuation must not require people to drive or walk through flood water.	Severe weather warnings are issued in advance of storm events and this will provide a buffer of a few hours in which those on site may leave prior to storms hitting the area.
	Development strategies relying on an assumption that mass rescue may be possible where evacuation either fails or is not implemented are not acceptable to the NSW SES.	

Principle 4 Decisions on development within the floodplain does not increase risk to life from flooding.	
Managing flood risks associated with Low Flood Islands requires careful consideration of development type, likely users, and their ability respond to minimise their risks. The site is considered a low flood island, as the definition of a low flood island is where "the roads can be cut by floodwater, closing all the evacuation routes and creating an island" and "the flood island is lower than the limit of flooding" (i.e. lower than the PMF).	The isolation period is less than 1 hour in a PMF and only marginally longer (2 to 2.5 hours based on the Victoria Rd sag) in a 1% AEP event which has reduced severity in that a 1% AEP event will not inundate the building. This is a manageable period of time with relatively low inconvenience to occupants.
The statement that "Even in a PMF event, emergency access to and from the site can be achieved via the Bridge St overpass" does not consider that there would be no flood-free access to the building, nor does it consider that this strategy relies on the stability of a bridge which would be exposed to H5 hazard floodwater.	The site has a flood free path to an emergency access point that is outside the 1% AEP and 0.2% AEP (1 in 500 year) flood extent.
Managing flood risks for low flood islands includes consideration of: Isolation – There is no known safe period of isolation in a flood, the longer the period of isolation the greater the risk to occupants who are isolated.	
Secondary risks – This includes fire and medical emergencies that can impact on the safety of people isolated by floodwater. The potential risk to occupants needs to be considered and managed in decision-making.	Whilst in a PMF event, the access point becomes inundated, the bridge itself remains above floodwaters. In the extremely rare event that a PMF flood (a 1 in 1,000,000 year event that impacts the emergency services access point for an hour or less) coincides with a secondary medical emergency, emergency services vehicles can wait north of the site and proceed only when floodwaters are obviously receding from the site.
Consideration of human behaviour – The behaviour of individuals such as choosing not to remain isolated from their family or social network in a building on a floor above the PMF for an extended flood duration or attempting to return to a building during a flood, needs to be considered.	The warning announcement will inform occupants that flooding recedes quickly in order to reduce the chance that they'll attempt to evacuate during an event. The announcement will tell them they must move to level one and not exit the building.
Ability of persons to access flood-free refuge – The rapid nature of flash flooding in this area may limit the ability of individuals to safely access higher levels prior to inundation of the ground level, particularly for individuals with less mobility.	This is discussed above. The building's ground level remains well-elevated above a 1 in 500 year flood but the emergency response acts on the assumption that any flood triggered by the sump alarm could be a PMF flood so timing is dictated by that event. Occupants are told to immediately progress to level one

Agency	Request	GRC Response
		and that immobile people have priority to use lifts for 8 minutes before they become parked on level one above the PMF level.
	The site is not suitable for shelter in place, due to the high hazard (H5 and H6) flooding both on the site immediately adjacent to the proposed building and on adjacent roadways.	The building is not impacted by H5 flooding in all events up to and including the 1 in 500 year event. The only event where H5 abuts the building is in the PMF event. The severity of a H5 flood hazard is understood and as such, the structural design of the building has been devised to withstand this situation.
	We also note that the site is prone to flash flooding with limited warning time, meaning that safe evacuation is unlikely to be feasible. Therefore, we recommend reconsidering development on the site, due to the significant flood risks, which have not been demonstrated to be sufficiently mitigated. We reiterate that the NSW SES is opposed to the imposition of development consent conditions requiring private flood evacuation plans rather than the application of sound land use planning and flood risk management.	
	We also recommend requesting clarification regarding how the site will ensure people do not enter high hazard flood areas. During a 1% AEP event, modelling shows the floodwater with depths of up to 1m would be immediately adjacent to the building, and flood depths more generally in this area would be greater than 1m during this event (in the area considered as flood storage). This depth increases to greater than 1m depth and H4 hazard immediately adjacent to the building during a 1% AEP + climate change modelling.	Doors will be automatically locked following the first 8 minutes after the alarm is triggered. (A manual override will be able to open this up if someone is attempting to enter at the 8 minute mark so that they're not automatically locked out). In a PMF event this would allow 5-8 minutes buffer time before the ground level is overtopped.
SES	*Climate change* Current evidence suggests that flood events will become more frequent due to climate change. A Climate Change Calculator has been developed to address the updated ARR climate change guidelines, recommending the adjustment of the BoM 2016 IFDs to account for the warming that has occurred since the mid-point of the data used for their development (1961-1990). This results in a significant increase in existing conditions flood levels. The change in flood probabilities with climate change results in the new probability of the 1 in 100 AEP for the current 2025 scenario to be approximately 1 in 54 AEP event for the Parramatta River and approximately 1 in 38 AEP event for the local catchment area, with these events becoming even more frequent in the future. For the proposed development site, this could result in more frequent inundation and isolation than what is currently expected based on previous modelling.	A factored 1% AEP event that incorporates a loading to emulate present-day climate change has been added to the modelling suite and compliance has been demonstrated against this design event.

Agency	Request	GRC Response
SES	Principle 5 Risks faced by the itinerant population need to be managed.	Risks at the proposed development has been managed by design and with an emergency response plan to manage any residual risk that exists beyond the development's design. Residual risks at the proposed development only includes flood events rarer than a 1 in 500 year event. Occupants remain flood free in the 1 in 500 year event and events more common than that.
SES	Principle 6 Recognise the need for effective flood warning and associated limitations. An effective flood warning strategy with clear and concise messaging understood by the community is key to providing the community an opportunity to respond to a flood threat in an appropriate and timely manner. Whilst we support the idea that "warnings will be clearly communicated to… would-be users of the site via a range of electronic and aural means both on-site and offsite (to discourage people trying to travel to the site)", we recommend that this is done prior to the start of the university day. To do this, we recommend implementing early triggers in the FERP, such Severe Weather Warnings from the Bureau of Meteorology. This is particularly challenging and likely to result in many "false alarms" as there are no formal warning systems for flooding at the site. We also note that NSW SES utilises the Australian Warning System (AWS) which is a nationally consistent, three-tiered approach to issue clear warnings and lead people to take action ahead of severe weather events. We therefore recommend removing the phrase "evacuation order(s)" from the FIRA and other relevant documents, as this terminology is now outdated.	The FERP has been updated with a more simplified strategy. An early warning has been adopted as per SES advice with the adoption of Severe Weather Warnings from the Bureau of Meteorology and the estimated daily rainfall exceeding 100 mm as a trigger to ask staff and personnel to stay home, work remotely and cancel or postpone any planned events that day. This warning should be issued as soon as the Severe Weather Warning is issued by BoM. The shelter in place response is preserved in the event that some staff or occupants choose to come into the building despite the request to stay home.
SES	Principle 7 Ongoing community awareness of flooding is critical to assist effective emergency response	Flood awareness will be ongoing at the site with visual aids, posters, signage, emails, texts and announcements reminding staff and students of the site's flood liability.

Agency	Request	GRC Response
CPHR	Flood Model And Flood Behaviour CPHR understands that City of Parramatta Council accepts the GRC Hydro model for the purposes of assessing this development due to errors in the model used for the Parramatta River Flood Study model. Nevertheless, CPHR is not satisfied that the model accurately represents local overland flooding. The model does not provide sufficient detail to make assertions regarding local overland flooding of Victoria Road, because runoff from Victoria Road has been applied in the model either upstream or downstream of the road itself. Sub-catchments should be discretised for the road surface and relevant pits and pipes should be included in the model. This is particularly important given that the road is 6 lanes wide and rises to a bridge for a significant distance in the order of 500m. This road catchment could create local overland flooding when pit capacities are significantly exceeded. Shorter storm durations would be critical compared to those for Vineyard Creek. Only with the above additional detail in the model would it be possible to make conclusions about the frequency of local overland flooding in Victoria Road and therefore the frequency with which access and egress is lost. CPHR recommendation The FIRA is updated to refine the hydrological and hydraulic models to accurately represent local overland flooding on Victoria Road.	The FIRA has been updated to refine the hydrological and hydraulic models to more accurately represent local overland flooding on Victoria Road.
CPHR	CPHR previously requested consideration of flood impacts for the full range of flood events. Only the 1% Annual Exceedance Probability (AEP) flood event has been considered. Impacts for the 5% AEP flood event and the Probable Maximum Flood (PMF) should also be modelled to understand the impact of the development on flood behaviour for a range of flood events. Hazard mapping in the FIRA indicates that the development would increase hazard in the PMF. CPHR recommendation The FIRA is updated to consider flood impacts for the full range of flooding.	These impacts have been mapped and included in the updated FIRA.

Agency	Request	GRC Response
CPHR	As stated in the above recommendation, further modelling is needed to address local overland flooding on Victoria Road. This revised modelling may lead to a higher frequency of inundation and isolation, which would increase the risk of several adverse outcomes, as previously advised by CPHR. CPHR recommendation Following the completion of updated modelling, which is to include local overland flooding on Victoria Road, the discussion in the FIRA on access and egress should be updated.	Has been included in the updated FIRA.
CPHR	In the PMF, floodwater from Vineyard Creek would inundate the ground floor to a depth in the order of 1.3m. The FIRA maps high hazard floodwater around the proposed building and on surrounding roads. The Parramatta River PMF would also isolate the site. CPHR previously recommended consideration of the time duration of isolation from a range of storm durations. CPHR anticipates that the duration of isolation could be over 12 hours, and this has been confirmed in another study. CPHR recommendation The consent authority considers the risk associated with high hazard flooding and the potential for long duration flooding.	The modelled local PMF inundates the ground floor level for less than 1 hour. The updated FERP demands all staff, students and guests leave the site if a severe weather emergency is predicted and the estimated daily rainfall exceeds 100 mm. A shelter-in-place strategy has been kept in place as a back-up system to inform occupants on how to respond if there happens to be any people present at the site if an emergency occurs.
CPHR	CPHR previously advised that shelter in place is not considered suitable in areas of high hazard flooding or when the duration of isolation is not short. While the FIRA has assessed the development against the Shelter-in-Place guideline for flash flooding, the commentary on page 107 has omitted that the PMF would cause high hazard flooding around the proposed building and on surrounding roads. Therefore, the requirement under item 8c of the guideline has not been met. CPHR recommendation The consent authority considers the risks associated with sheltering in place with high hazard flooding.	The updated FERP identifies early warning evacuation as the primary response. WSU will demand all staff, students and guests leave or stay away from the site if a severe weather emergency is predicted and the estimated daily rainfall exceeds 100 mm. A shelter-in-place strategy has been kept in place as a back-up system to inform occupants on how to respond, if there happens to be any people present at the site if an emergency occurs.

CPHR	CPHR previously raised several issues with the FERP that have not been adequately addressed: • Details of "back up power and water provision" should be provided given the sensitive nature of this development. • Details should be provided on the number of occupants on the ground floor and how much space per person would be available in the shelter locations. • The nominated emergency access point immediately south of the proposed building's southern entrance would not provide emergency access as the area is subject to H4 hazard in the PMF. • The FERP suggests that "staff should specifically look for warnings related to Parramatta River". The FIRA should clearly state that: • - BOM issues severe weather warnings and flood watches, but does not issue flood warnings for the Parramatta River • - Flood Watches may provide advanced notice of flooding, but these would not provide advanced notice for all flood producing rain events affecting the development site. • - Severe weather warnings would not be issued for all flood-producing rain events affecting the development site. • CPHR is concerned that there is insufficient time to relocate the number of people on the ground floor to the first floor with a warning time of less than 20 minutes. The FIRA has not demonstrated that the time available would be sufficient for flood wardens to initiate relocation of occupants and complete this process. • In addition to the above, CPHR has identified further issues in the latest FIRA: • While Bridge Street may remain low hazard in a PMF event, the building itself is surrounded by high hazard floodwater, which is unsafe for people and vehicles. Bridge Street is also one-way in the direction towards the university. While it may be acceptable for emergency vehicles to travel in the opposite direction of traffic, this may not be feasible for an evacuation. • Further, on arrival in James Ruse Drive, vehicles would need to turn left and from there either return to Victoria Road, which would be flooded or continue south along James Ruse Drive to Camellia, which would also be flooded. CPHR therefore does not recommend the FIRA or FERP state that emergency services can assist occupants via	The FERP and emergency strategy in general has been updated to be more conservative and demand all staff, students and occupants to leave or stay away from the site when a severe weather warning is issued and the estimated daily rainfall exceeds 100 mm for Sydney (not just focused on an event specific to the Parramatta area.) Reliance on FloodSmart has also been removed. The point is taken that not all rain producing events at the site will be captured by a severe weather warning. The proposed development is passively flood protected higher than the 1 in 500 year flood. It is unlikely that a storm event capable of generating 1 in 500 year flows will not be captured in a severe weather warning. The emergency response has been updated with the goal that the site is completely empty when a flood event occurs. However, a back-up shelter-in-place procedure has been left in place so that any people who happen to be present at the time will have ample guidance on how to respond and the importance of acting quickly will be stressed. Backup power will be assured for a designated shelter-in-place area through the installation of a battery (with back-up protection) in a flood-safe location well above the PMF level. This battery will support basic systems such as some lights and power outlets that can be used to charge phones. It will not be used to continue lift usage. The specific details of the battery system and its placement can be provided as a condition of consent. A backup water tank will also be installed in a flood-safe location that can provide drinking water for the short duration of isolation. The operational intent is that no-one is present at the site during a flood event and the only event to overtop the ground floor – the PMF event – has been modelled to recede within 1 hour – a manageable period in which to shelter in place with only limited power. Bridge Street's usage in emergency response would be restricted to emergency service vehicles only and only in times where:

Agency	Request	GRC Response
	Bridge Street. Further, it should not be suggested that the site can be evacuated via Bridge Street. • Section 7.4 and subsection 7.4.2.2 suggest evacuation notices be issued, which contradicts the recommended shelter in place strategy. Similarly, Section 7.4.2.1 refers to the shelter in place strategy as a contingency. Early closure may instead be considered in response to flood watches or FloodSmart warnings. The FIRA must be clear and consistent on the proposed emergency management strategy. • Figure 52 should be deleted as the location is subject to H4 flooding in a PMF. Figure 53 should also be deleted as access to the building during a flood event should not be promoted. • The FloodSmart system should not be relied upon to inform development assessment. Warnings provided by the system cannot be expected to provide sufficient warning for this development. This is in part due to the very short time to onset of site flooding, which is established as 20 minutes in the FIRA. CPHR recommendation The FERP section of the FIRA should be updated in accordance with the above comments and document the risks associated with the very short warning time.	• A 000 emergency request has been called to the site, and • Emergency personnel can confirm, with cooperation from occupants on site (the subject of the emergency or people supporting them), that the roadway west and south of the site's main entrance is flood free and a flood free connection with the building is maintained. In a PMF event, it's likely that emergency services personnel will be staying put in a safe location until the peak of the event subsides anyway, so people needing assistance at the site are unlikely to be any different to others needing assistance along the Parramatta River during such a severe event.

COP	*Rainfall Intensity and Temporal Pattern :* The 19% increase in rainfall intensity (with the highest temporal pattern) appears to have only been used in sensitivity analysis.	GRC has modelled this scenario and included results and impacts. See Figures 23-24, 48-50.
	This increment and temporal pattern should be included in the base case/design case for all design, flood impact assessment, and flood planning level calculations, as this allowance is for Flood Frequency Analysis calibration and is adopted.	Other agencies have requested we adopt a 1% AEP with scaling in alignment with what ARR considers as 'present-day climate change.' This is approximately equivalent to an 11% rainfall in increase on top of the 1% AEP event. This has been adopted as the compliance event in keeping with agency requests. See Figures 21-22, 45-47.
	Hydraulic Consistency: Confirm that upstream flows at Victoria Road bridge match the adopted Parramatta River Flood Study.	GRC's modelling has been adopted at the site as the PRFS model was found to be unsuitable. GRC's previous reporting has documented the verification of the model and we refer Council to that.
	Flood Storage: Any loss of flood storage (up to 1%FFA AEP, adjusted for the 19% rainfall increment) must be compensated. Provide cross-sections and volume calculations to demonstrate compliance.	Previous versions of works preserved all storage by retaining an open undercroft area. However based on CoP's preference the works are now slab on ground. This does involve 2,200 m^3 of flood storage being lost on the site (which is approximately 0.5% of total event volume in the defined event). Despite this minor loss of flood storage at the terminal end of the catchment, the detailed impact assessment carried out indicates no downstream or upstream impact. For loss of storage, under standard hydrological theory any impact would be in the downstream. As per GRC's impact mapping reported herein there is no impact.
	Flood Depths: The post-development scenario shows flood depths >1m (highlighted in yellow). Explain how this will be managed. If this area is a detention basin, provide design and safety details and confirm if it triggers Dam Safety NSW requirements.	This area is not a detention basin. It is only temporarily inundated in rare storm events and it will be drained by a pipe that connects with the existing stormwater infrastructure that drains to Vineyard Creek.
	Safety: Consider fencing and other safety measures where required.	Fencing should not be required given that the ordinary state of the site is that it would be completely free of water or have a shallow puddle at its lowest point. By contrast, Vineyard Creek, north of Victoria Road is not fenced.
	Overland Flow: Design and incorporate a safe overland flow path from the oval.	A depression along the site's northern boundary facilitates a safe flow path from the oval to the site. This flow path is located in an area that is rarely trafficked by pedestrians and the flow path travels beneath the section of Bridge Rd that overpasses Victoria Rd.

Agency	Request	GRC Response
	Flood Impact Assessment: Page 5 of 8 • Clarify if the assessment includes the 1%AEP + 19% rainfall increment with highest TP.	The assessment using the 19% factor is presented in Figures 23-24, 48-50. However, we remind Council that the Defined Flood Event for this report is the 1% AEP with present day climate change as described above.
	• Removing flood storage is unlikely to have no impact—provide evidence.	Detailed impact assessment has been carried out. For loss of storage, under standard hydrological theory and impact would be in the downstream. As per GRC's impact mapping reported herein there is no impact. See Figures 21-22, 45-47.
	• Address the cause of the 10–100 mm flood afflux on the western side; ensure no worsening of existing flooding.	Detailed impact assessment has been carried out. As per GRC's impact mapping reported herein there is no impact off-site and the proposed works comply with requirements regarding FPL. See Figures 21-22, 45-47.
	Flow leaving the subject site: Provide a table with comparison of Pre-Development and Post Development Flows (Pipe Flow, Overland Flow and combined pipe & overland flow) leaving the site at each of the locations. Discharge should be less than pre-development flows.	This has been included within the report in Section 6.3.8
	Updated electronic copy of the models need to be submitted along with the results for review with incorporation of all of our comments.	This will be submitted separately to this report.
DPHI	Flooding The Department raises concerns regarding the high flood hazard present near and within the site, including the new carparks. The significant flood affection warrants a comprehensive flood assessment and robust emergency response measures.	The new car park areas have now been incorporated into the FIRA. However, the new carparks are not flood affected in even the 0.2% AEP event. PMF hazard on both sites is mainly low hazard (H1-H3).

3. Introduction

3.1 Site Location and Description

The Western Sydney University South Parramatta Campus is located within the City of Parramatta Local Government Area (LGA).

The site is legally described as Lot 100 and 101 in DP 816829 and largely comprises the P1 Car Park and grassed embankments along Fifth Street in the northern portion of the wider site campus. The site location and project boundary is identified in Figure 1.

Figure 1: Western Sydney University Parramatta South Campus locational context



Source: Nearmap/Ethos Urban

The site is located approximately 3 km east of the Parramatta CBD and is also located adjacent to the recently completed Parramatta Light Rail Corridor, with direct access to the Yallamundi Light Rail stop.

4 Project Description

The Applicant seeks development consent for the construction of a new state-of-the-art Indigenous Centre of Excellence as a new tertiary education facility on campus. The Indigenous Centre of Excellence project is funded by the NSW Government's Western Sydney Infrastructure Grants Program in association with Western Sydney University. The new Indigenous Centre of Excellence will be an important asset for both the

University and local community alike, providing a space for the commitment to advancing Indigenous education, leadership, and reconciliation.

This State Significant Development Application (SSDA) specifically seeks detailed approval for the following works:

- Site preparation including demolition of the existing car park, tree removal and installation of inground utility infrastructure services.
- Construction of a four-storey Indigenous Centre of Excellence encompassing the following facilities:
  - Outdoor amphitheatre,
  - Cinema and lecture theatre,
  - Artist studios and gallery exhibition space.
  - Teaching workspaces and general study areas,
  - Library and other educational research spaces,
  - Multi-functional recreational sports court, with ancillary amenities, and
  - Astronomy garden.
- Construction of hardstand paving and line marking to accommodate new parking areas, including:
  - 13 spaces on the existing P1 car park site, adjacent to the new dedicated arrival zone to the proposed ICoE,
  - 107 spaces proposed in new western car park to the west of Bridge Street, adjacent to the existing oval, and
  - 181 spaces proposed in new eastern car park on the southern side of Fifth Street, adjacent to the new ICoE.
- Landscaping works to provide outdoor educational and recreational spaces.

This report responds to the relevant SSD-64916225 Secretary's Environmental Assessment Requirement (SEARs), as well as addresses updated Amending SSD cumulative impacts associated with the revised car park scope.

Flood Risk Assessment	15. Flooding Risk • Identify any flood risk on-site having regard to adopted flood studies, the potential effects of climate change, and any relevant provisions of the NSW Floodplain Development Manual. • Assess the impacts of the development, including any changes to flood risk on-site or off-site, and detail design solutions and operational procedures to mitigate flood risk where required.

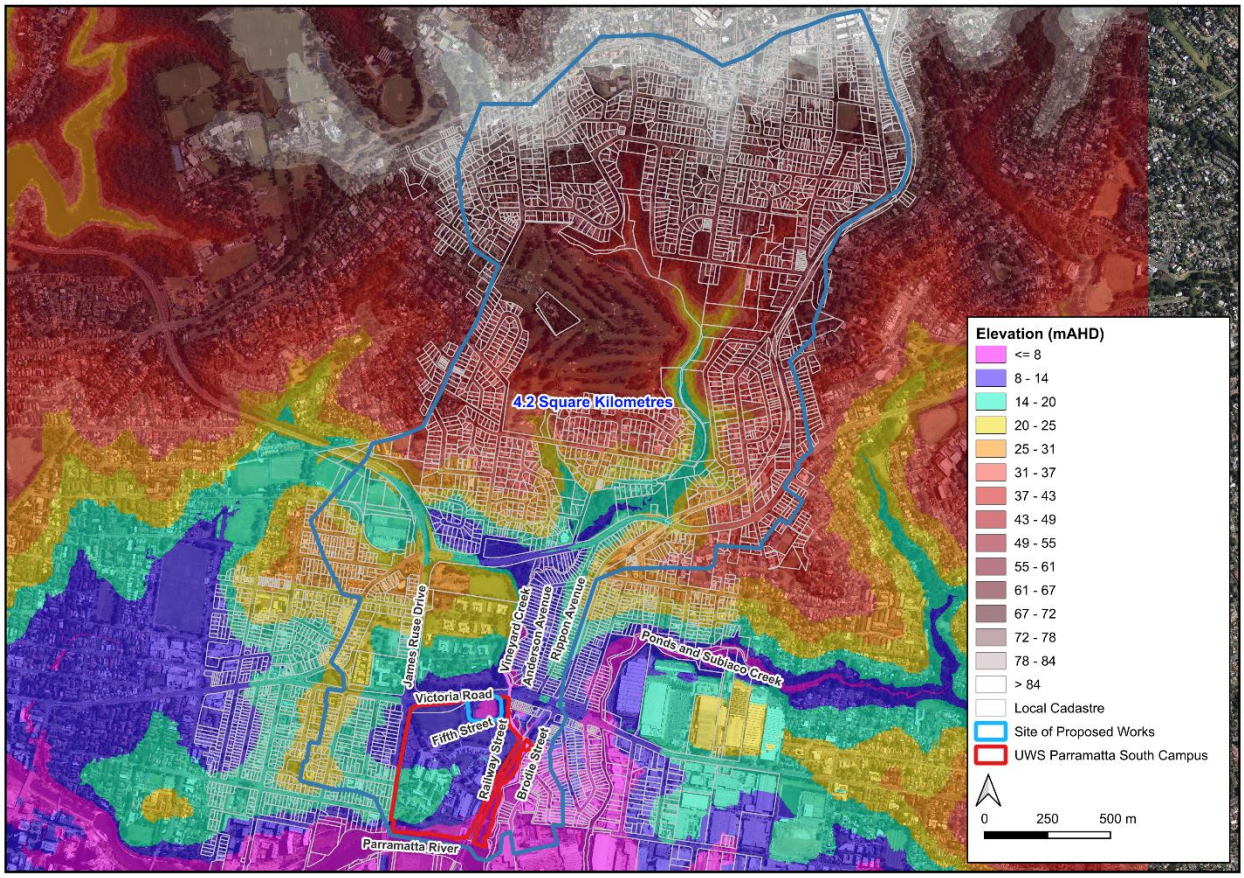
Riparian Zone Management Assessment	Riparian Zone Management • Where applicable, provide a Riparian Zone Management Assessment prepared by a suitably qualified professional, to determine the presence of mapped and potential unmapped waterways across the site and where relevant to map the top of bank of waterways to determine appropriate Vegetated Riparian Zones (VRZ) and riparian zone management as required by NSW Water Management Act 2000.

4.1 Topographic Context

The proposed development is to be situated in the north-western corner of the site where an open-air, on ground car park is currently situated (as documented in Figure 1 above).

The site is situated north of the Parramatta River and immediately west of Vineyard Creek, a tributary of the Parramatta River that drains a catchment of approximately 4.2 km^2. The site is located towards the bottom of this catchment.

Figure 2: Vineyard Creek Catchment



The site is identified by Council as flood-liable and as such, a Flood Impact Risk Assessment (FIRA), a Riparian Zone Management Assessment (RZMA) and Flood Emergency Response Plan (FERP) is required to be submitted as part of the State Significant Development Application to confirm the proposed development has been designed to accommodate the local flooding regime and is compliant with flood-related controls and guidance outlined in Council and State planning instruments. These include Local Environmental Plans (LEP), Development Control Plans (DCP) and any Secretary's Environmental Assessment Requirements (SEARs) issued for the site by the NSW Department of Planning, Housing and Infrastructure (DPHI).

4.2 Project Scope

GRC Hydro (GRC) has been engaged to prepare the FIRA and FERP for this proposed development. These items are presented herein.

The work undertaken to complete this report includes:

- Engaging with the City of Parramatta (Council) to confirm the Council-endorsed flood levels and extents for the site in its existing case;

- Developing a best practice hydrological and hydraulic model to derive local flood depths, flood levels, hazards and velocities for the following events (20%, 5%, 1%, 0.2% and PMF) in the existing and post-developed case;
- Assess the site's flood affectation in a future climate change scenario in accordance with the NSW Department of Planning and Environment's (DPE) Flood Risk Management Guideline FB01. This has been conducted through the modelling of a 1% AEP + RCP 4.5 2050 and 1% AEP + RCP 4.5 2090 event in both an existing and post-developed scenario;
- Assess the proposed development and modelled flood affectation relative to planning instruments applicable for the site, such as:
    - The Parramatta Local Environmental Plan 2023 (PLEP 2023);
    - The Parramatta Development Control Plan 2023 (PDCP 2023);
    - The SEARs issued for the site by NSW DPHI.
- Assess the proposed development's opportunities for safe shelter and/or evacuation in the event of a flood emergency; and
- Summarise the above in a FIRA, RZMA and FERP.

This assessment has been informed by the NSW DPE's *Flood Risk Management Manual* (2023) (FRMM 2023). Reference to how this report has addressed the FRMM 2023 is outlined in detail in Appendix C.

5 The Site's Flood Liability

The site is flood liable when Vineyard Creek flow overtops its banks at Victoria Road, enters Victoria Road and then flows into the site.

The site is bordered to the west by an oval which is elevated slightly higher (8.4 mAHD) than the existing car park site (7.5 mAHD) and the oval drains toward the existing car park via a swale which travels eastward from the north-east corner of the oval, beneath Bridge Street's overpass and connects with the north-western corner of the car park.

This flood liability has been documented in the City of Parramatta's (Council's) provided flood certificate. This flood certificate summarises Council's adopted flood levels in the vicinity of the site and has been attached to this report in Appendix A.

Figure 3: Flood Extents at the Site (Council)



Rather than specify a fixed flood level for the site, the flood certificate sets out 5% AEP, 1% AEP and PMF flood levels in the vicinity of the site, on a map.

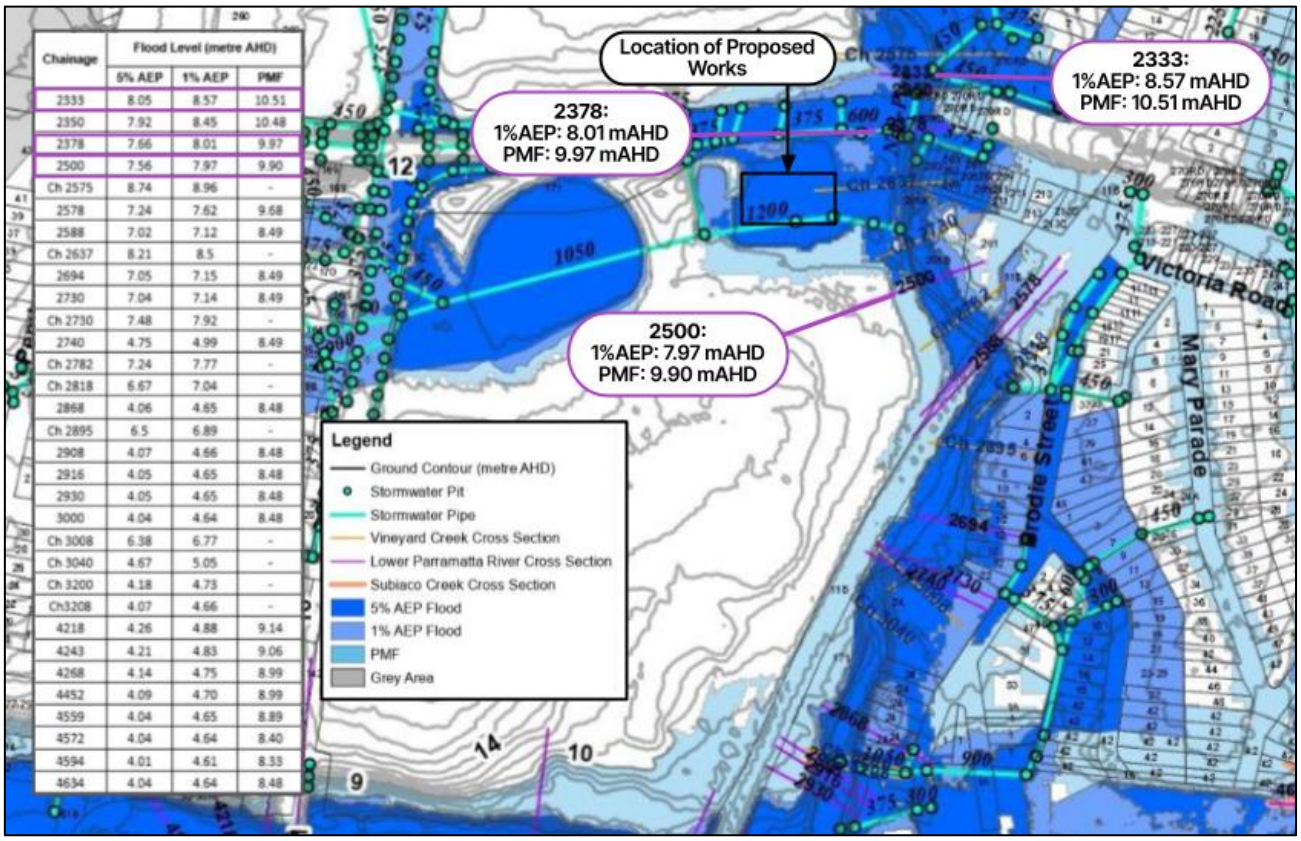
The map documents flood levels along Vineyard Creek that have been sourced from two Council-endorsed flood studies. These are:

- Vineyard Creek Sub-Catchment Management Plan, 2004 (SMEC); and
- Lower Parramatta River Floodplain Risk Management Plan – Flood Study Review, 2005 (SKM)

The *Lower Parramatta River Floodplain Risk Management Plan – Flood Study Review* (referred henceforth as "SKM 2005") is the most recent of these studies and the flood mapping documents a 1% AEP and PMF flood level at each chainage location.

Analysis of the SKM 2005 flood levels documented in the vicinity of the site show the site is flooded to a level of approximately 8.0 mAHD in a 1% AEP event. With site ground levels around 7.5 mAHD, this equates to depths of around 0.5 m across the site.

Figure 4: Council Provided Flood Levels for Vineyard Creek



Chainage	Flood Level (metre AHD)		
	5% AEP	1% AEP	PMF
2333	8.05	8.57	10.51
2350	7.92	8.45	10.48
2378	7.66	8.01	9.97
2500	7.56	7.97	9.90
Ch 2575	8.74	8.96	-
2578	7.24	7.62	9.68
2588	7.02	7.12	8.49
Ch 2637	8.21	8.5	-
2694	7.05	7.15	8.49
2730	7.04	7.14	8.49
Ch 2730	7.48	7.92	-
2740	4.75	4.99	8.49
Ch 2782	7.24	7.77	-
Ch 2818	6.67	7.04	-
2868	4.06	4.65	8.48
Ch 2895	6.5	6.89	-
2908	4.07	4.66	8.48
2916	4.05	4.65	8.48
2930	4.05	4.65	8.48
3000	4.04	4.64	8.48
Ch 3008	6.38	6.77	-
Ch 3040	4.67	5.05	-
Ch 3200	4.18	4.73	-
Ch3208	4.07	4.66	-
4218	4.26	4.88	9.14
4243	4.21	4.83	9.06
4268	4.14	4.75	8.99
4452	4.09	4.70	8.99
4559	4.04	4.65	8.89
4572	4.04	4.64	8.40
4594	4.01	4.61	8.33
4634	4.04	4.64	8.48

A third study was reviewed that provided information on flooding in the catchment; the *Rydalmere Development Precinct Watercycle & Flood Management Strategy Report* (J. Wyndham Prince, 2016). This study established a hydrologic model (XP-RAFTS) and hydraulic modelling (TUFLOW) in aid of assessing a planning proposal in the catchment. The model parameters, specifically the rainfall losses, being the default values as per the 1987 Australian Rainfall and Runoff were adopted for the current study (see Hydrological Model section).

6 Flood Modelling

Flood modelling of the proposed development was required in order to determine how the proposed development may impact the local flooding regime.

GRC's preferred method is always to use the endorsed Council flood model for the catchment in which a development is proposed.

GRC emailed and phoned Council flooding staff in February 2024 to seek the endorsed model for the Vineyard Creek catchment but received no response from Council.

This resulted in GRC needing to develop a model to better understand the local flooding regime and potential impacts of the proposed development.

For reference purposes, in the course of building this model, GRC has reviewed reports outlining modelling previously conducted for this catchment including the Draft Parramatta River Flood Study (Stantec, 2023).

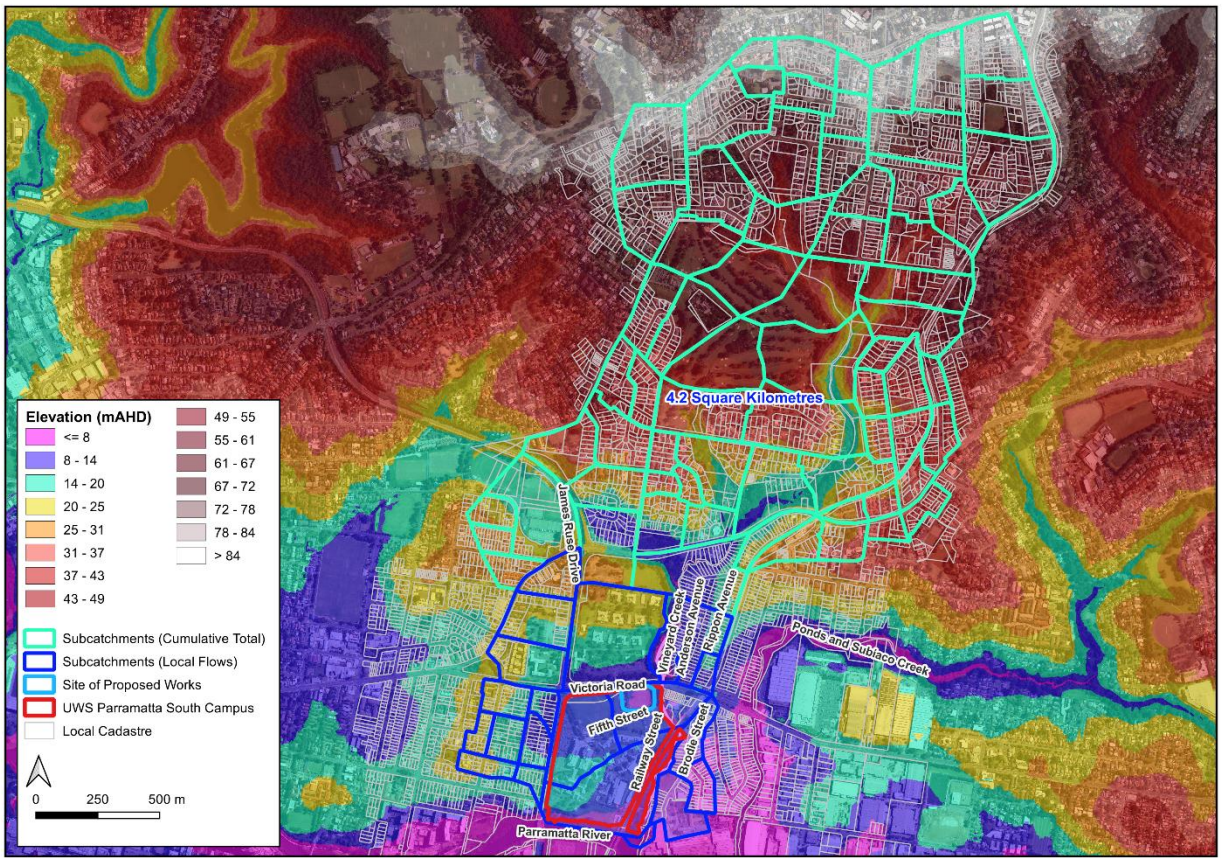
6.1 Hydrological Model

A hydrological model for Vineyard Creek catchment to Parramatta River in the downstream, covering an area of approximately 4.2 km^2, was set up using the Watershed Bounded Network Model (WBNM). The main flow from the catchment – conveyed through Vineyard Creek – runs along the eastern boundary of the site under investigation. The catchment was sub-divided into 90 sub-catchments, taking into consideration both natural topographic characteristics of the catchment as well as urban features within that have the potential of altering flow paths between the delineated sub-catchments (Figure 5).

A large sub-catchment north of the site has been divided into two sub-catchments to more accurately represent the local inflows from the Victoria Road upstream area and the Vineyard Creek catchment, in accordance with SES requirements.

The advantage of the WBNM model is it has been built to produce probability equivalent flows in South-East Australia as well as its requirement for relatively few parameters in order to produce a reasonable hydrological representation of a modelled area. Those parameters of interest are summarised below.

Figure 5: Hydrological Sub-catchments



6.1.1 Rainfall Losses

In the absence of calibration data for the catchment, storm Initial Losses (IL) and Continuing Losses (CL) have been adopted from the 2016 catchment study (Rydalmere Development Precinct Watercycle & Flood Management Strategy Report, Initial Investigation, J. Wyndham Prince). Noting that these loss values were also the default loses for use in NSW as per the 1987 edition of ARR. The resulting design flood levels were then compared to the flood levels provided on Council's flood certificate. Table 2 summarises the losses used in this study.

Table 2: Losses adopted in the hydrological model

Event	Initial Loss (IL) [mm]		Continuing Loss (CL) [mm/hr]
	Impervious	Pervious	
20, 5, 1 % AEP	1	15	2.5
PMF	0	0	1

6.1.2 Lag Parameter

As recommended by WBNM documentation, a lag parameter of 1.6 was adopted. Nevertheless, other values were tested in order to have a sense on how adjusting this parameter would affect the catchment response; in addition to seeing whether that would improve the convergence between the results from the current study and suggested results from former reports.

6.1.3 Imperviousness

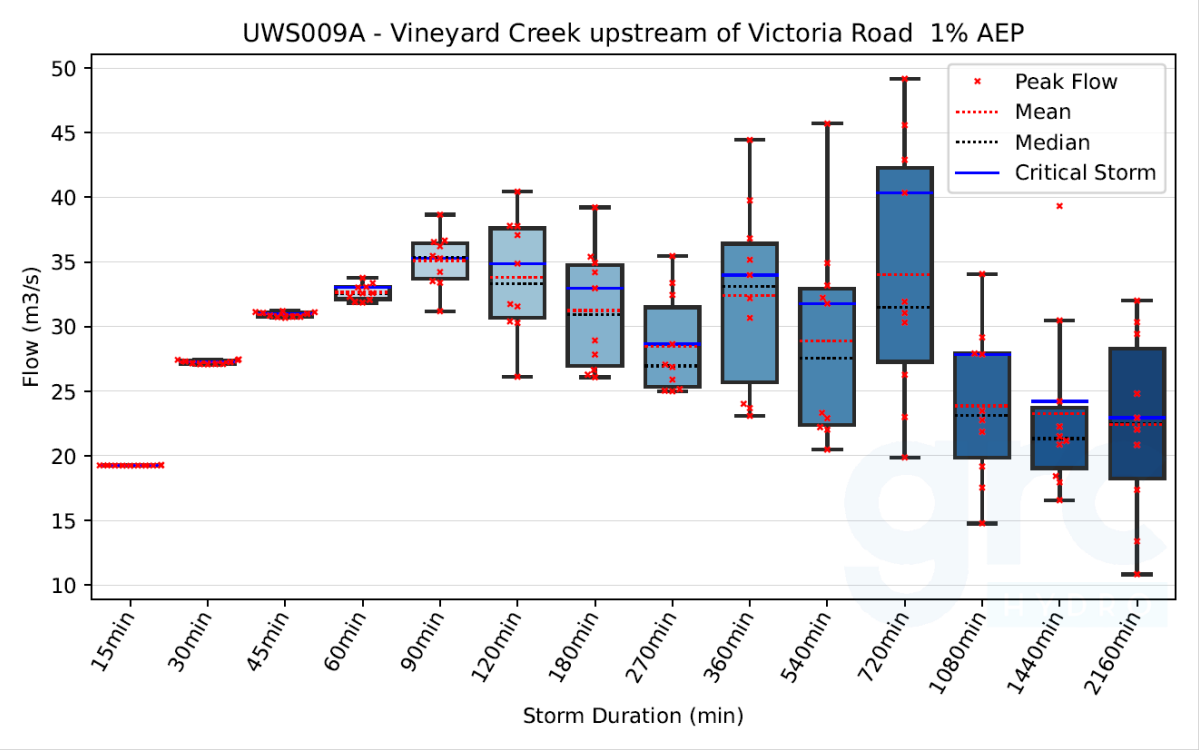
An impervious parameter was set for each model sub catchment, based on the land use in that area. In order to estimate imperviousness within the study area, the ESA Land Use and Land Cover product was used, which shows the 'Built Area' class within each catchment, which was treated as 100% impervious, and then averaged with the pervious areas, for each catchment, to get the percentage impervious.

6.1.4 Temporal Patterns and Critical Duration Assessment

Rainfall temporal patterns are used to describe how rainfall is distributed over time. The recommended ARR2019 ensemble approach to applying temporal patterns has been utilised in the current study. The ensemble approach to flood modelling applies a suite of 10 different temporal patterns for each duration. Temporal patterns were obtained from ARR2019 for the 'East Coast South' region from the ARR Data Hub. Point temporal patterns were used as the catchment area is smaller than 75 km².

The critical duration assessment is shown in Figure 6 below, for the 1% AEP event. As shown, durations of 60 minutes up to 720 minutes (12 hours) all produce a critical storm peak flow of between around 33 to 40 m^3/s. The critical duration is 720 minutes/12 hours, which produces the highest peak flow of the critical storms (~40 m^3/s). It is noteworthy that 720 min temporal patterns were assessed and TP01, TP05 and TP09 were all found to contain embedded bursts which exceed 1% AEP rainfall. As such it is apparent that the 1% AEP flow estimate derived herein is expected to be conservative (presuming neutral or conservative estimates elsewhere).

Figure 6: 1% AEP Hydrology - Duration and Temporal Pattern Distribution Box and Whisker Plot



6.1.5 Unit Flow Rate Comparison

In addition to that verification, the hydrologic model results were compared to unit flow rates in the Sydney basin, in the absence of other calibration data. Regional Flood Frequency Estimate was not considered for the catchment as the closest available catchments were around 25-100 km^2, much larger than the site's catchment.

The unit flow rate is calculated as the 1% AEP peak flow, divided by the catchment size, to give a flow rate per hectare.

$$Unit\ Flow\ Rate = \frac{1\%\ AEP\ Peak\ Flow}{Catchment\ Size\ (ha)}$$

GRC Hydro have estimated unit flow rates for many catchments across Sydney and find that values are consistently in the 0.1-0.4 m^3/s per hectare range, for urbanised overland flow catchments. Given the site's catchment is large (around 360 ha to Victoria Road) with large areas of native bush and including areas that hold water, its unit flow rate would be expected to be towards the lower end of the typical range.

At the subject site, the peak flow of 42 m^3/s (calculated for the 3.6 km^2 catchment (360 ha) upstream of Victoria Road) gives a unit flow rate of 0.12 m^3/s per hectare. This value falls within the expected range and indicates the hydrologic model estimates are on face value reliable.

6.2 Hydraulics

6.2.1 Topography

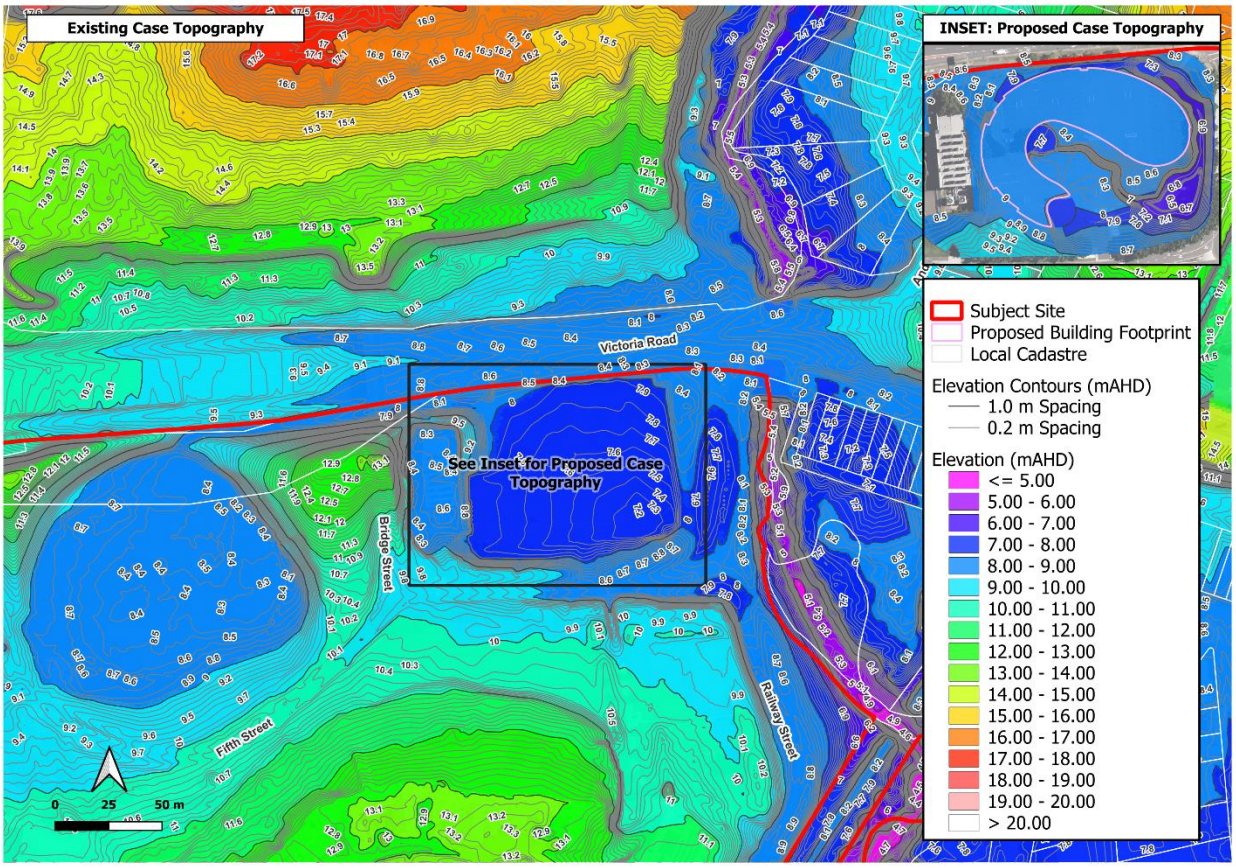
The topography within the model domain is represented by LiDAR sourced from NSW Spatial Services. This LiDAR surface was the most up-to-date available at the time of modelling and is representative of the local terrain as of June 2019.

GRC undertook a desktop review of this LiDAR for locations where structures may have been lacking accuracy due to local vegetation obscuring the aerial survey. GRC made some edits upstream and downstream of the Victoria Road culvert based on analysis of Lidar and our site inspections.

A survey TIN was integrated with the LiDAR for both existing and proposed conditions within the area surrounding the SSD Development Site. The surface grid was generated from a tinned surface provided to GRC by Western Sydney University (WSU) on 8 July 2024.

Where topographic changes are to be made as part of the proposed development, these have been represented in the model by a grid developed from a tinned surface supplied to GRC on 24/11/2025 by Taylor Thomson Whitting (TTW).

Figure 7: Site Topography and Proposed Changes



6.2.2 Material Roughness

Aerial imagery of the model domain was inspected and polygons representing the nature of the varied surface material were developed. These polygons are used in the hydraulic model to represent the different

types of surfaces water will travel across in the course of flooding. A different roughness coefficient is applied to each surface type. The roughness coefficient adopted for each surface type in the model is documented below in Table 3. Where appropriate, GRC has adopted the same roughness coefficients as have been used in the Draft Parramatta River Flood Study (DPRFS).

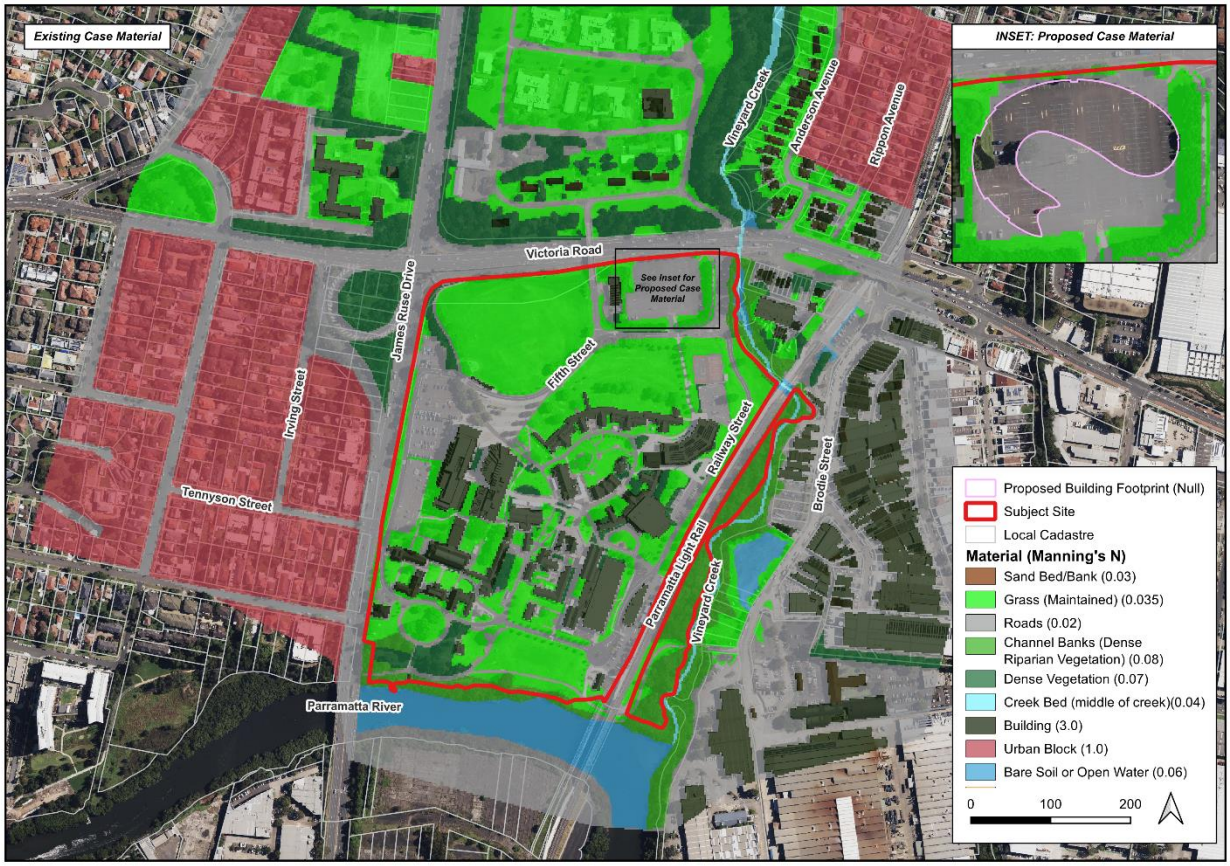
Table 3: Material Roughness Coefficients

Surface ID	Materials Roughness	Surface Type
1	0.04	Sand bed/bank
2	0.07	Grassy channels
3	0.035	Grass (maintained)- Value from DPRFS
4	0.05	Pasture
5	0.02	Roads- Value from DPRFS
6	0.013	Concrete Storage Areas
7	0.08	Channel Banks (Dense Riparian Vegetation)- Value from DPRFS
8	0.07	Dense Vegetation- Value from DPRFS
9	0.04	Creek Bed (middle of creek) mainly lower reaches
10	3	Building
11	1	Urban Block
12	0.02	Concrete in channel
13	0.06	Dams, open water, bare soil
17	0.12	Array of Building Piers

The proposed building has been blocked out. Buildings in the vicinity of the subject site have been modelled using a roughness coefficient of 3.

Mapping documenting the surfaces and roughness coefficients applied throughout this model is shown in Figure 8 below.

Figure 8: Material Roughness (Manning's N)



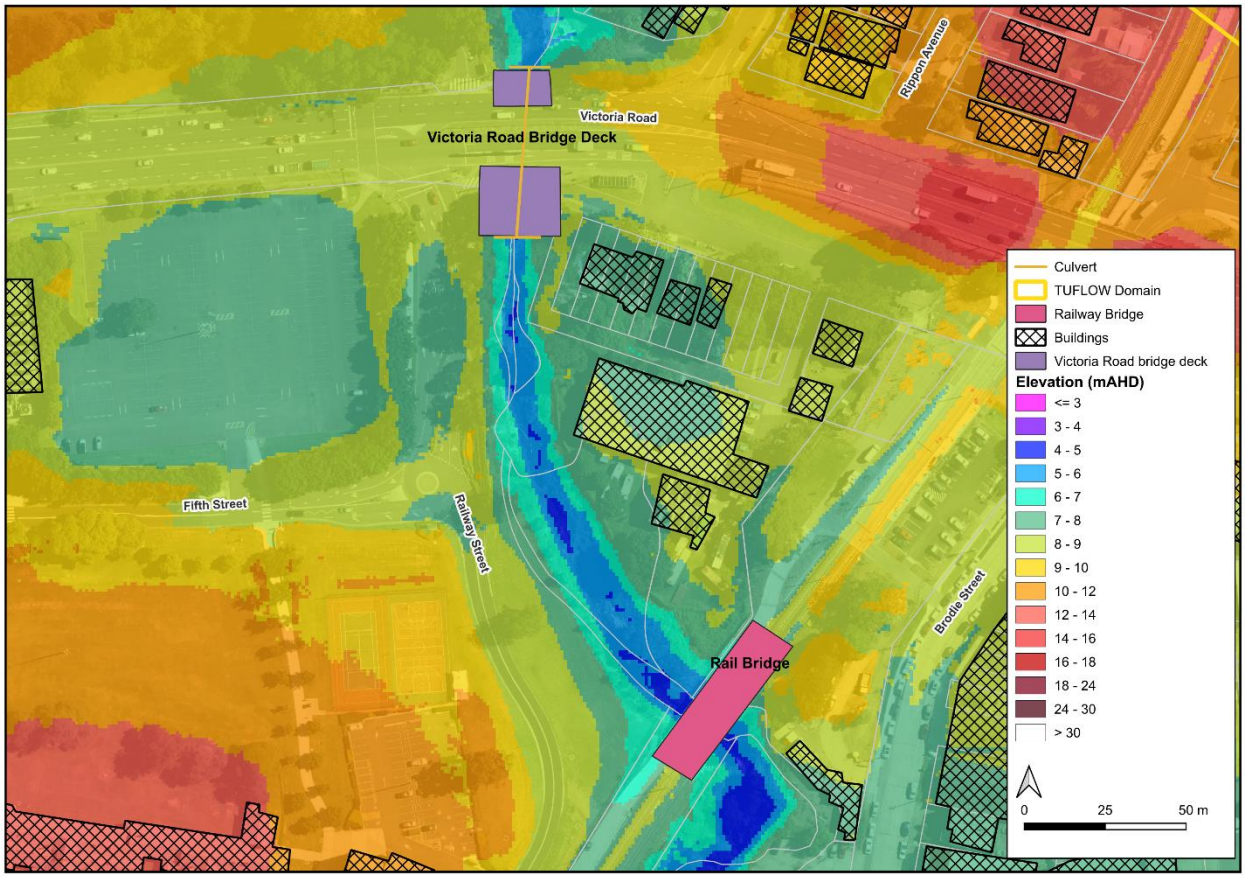
6.2.3 Structures

Vineyard Creek passes underneath two structures as it passes southward through the model domain. These include:

- Victoria Road crossing of Vineyard Creek. The structure is shown in Image 1. The dimensions were measured as part of a site visit. The structure is modelled in TUFLOW as a box culvert, with a 1% AEP design blockage of 15%, based on a ARR2019 Blockage Assessment; and
- A bridge deck and piers where a railway corridor passes above Vineyard Creek. This structure is shown in Image 2. A flow loss calculation was conducted for this structure, as was an ARR2019 Blockage Assessment. A 15% design blockage was adopted as a result.

These structures are identified in Figure 9 below.

Figure 9: Vineyard Creek Structures



6.2.4 Victoria Road Bridge Deck

Vineyard Creek passes beneath a bridge deck where Victoria Road crosses the creek. Victoria Rd is situated at the subject site's northern boundary.

GRC undertook a site visit to better understand the geometry of this structure.

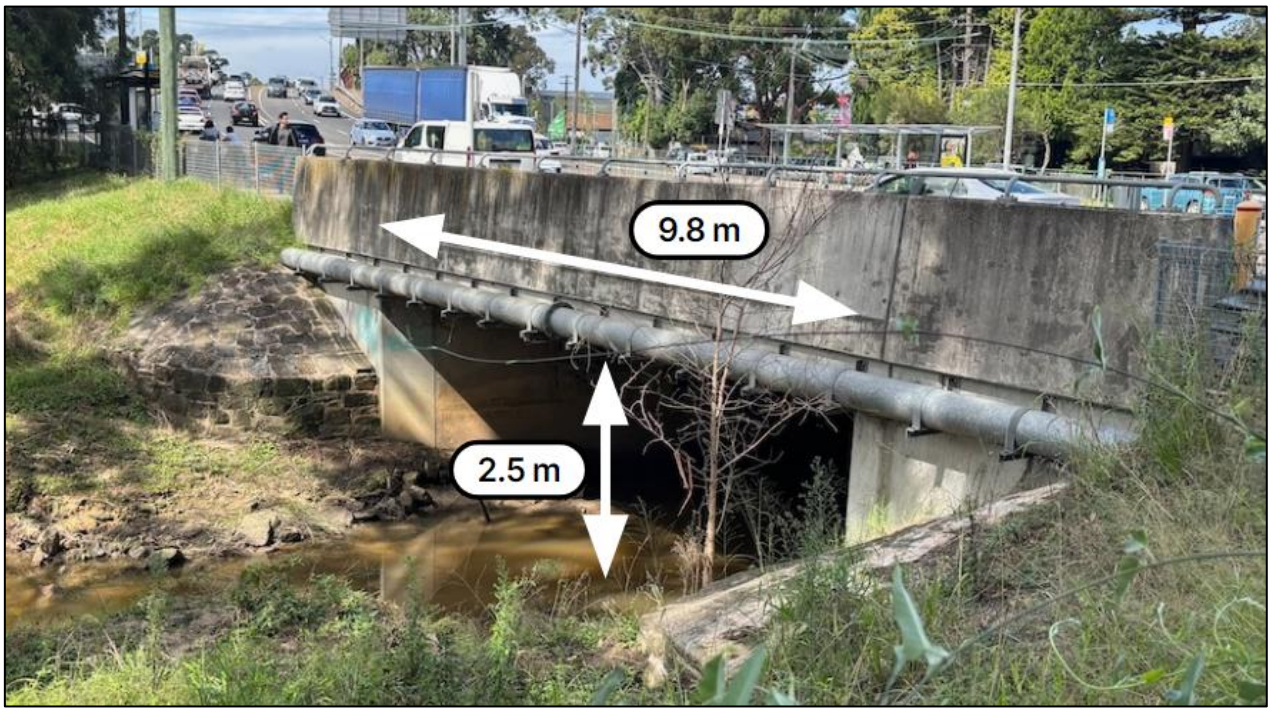
The upstream side of this structure is pictured in Image 1.

The dimensions of the void beneath this structure were measured by GRC and were found to be approximately 9.8 m wide and 2.5 m high from the bridge soffit to the creek's invert at this location.

Given the rectangular nature of this structure, it has been represented in the TUFLOW model as a box culvert.

An ARR 2019 Blockage Assessment has been undertaken for this structure and as such, a blockage factor of 15% has been applied at this structure in GRC's modelling.

Image 1: Victoria Road Bridge Deck and approximate dimensions (Upstream side)



6.2.5 Parramatta Light Rail Bridge

Vineyard Creek passes beneath the Parramatta Light Rail alignment downstream of the site. At this point a bridge deck, supported by a row of cylindrical piers, allows the track to pass across the top of Vineyard Creek.

GRC undertook a site visit to better understand the geometry of this structure.

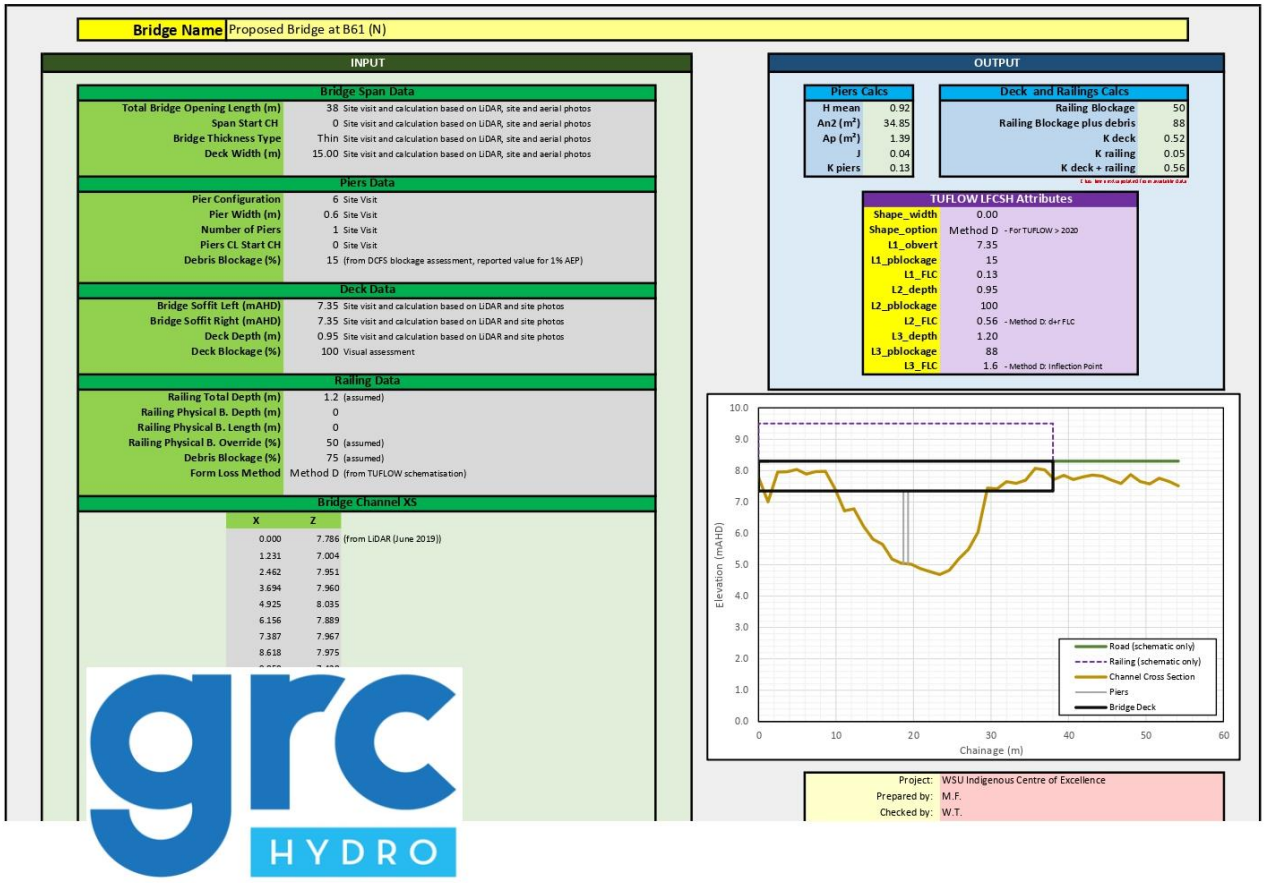
The upstream side of this structure is pictured in Image 2.

Image 2: Parramatta Light Rail Bridge (Upstream side)



A form loss calculation was undertaken for this structure in order to determine the appropriate parameters to represent this crossing in the TUFLOW model.

Figure 10: Form Loss Calculations (Parramatta Light Rail Bridge Crossing)



An ARR 2019 Blockage Assessment was undertaken for this structure and as a result of this assessment, a blockage factor of 15% has been applied at this structure in GRC's modelling.

6.2.6 Stormwater Network

Council provided its stormwater network data to GRC as part of its handover of the Parramatta River Flood Study 2024 model. GRC has incorporated this provided stormwater network in this revised modelling.

An amendment was made to the existing pits and pipes in the baseline model. A missing pit and pipe located on the northern side of Victoria Road near the site was identified during the site visit. This structure was assumed to have the same size and diameter as the connected downstream stormwater asset. Given its influence on site surrounding overland flow behaviour, it has been added to the stormwater system for both the existing and proposed conditions.

6.2.7 Upstream Flow Boundary

The WBNM generated flows for the 90 Vineyard Creek sub-catchments identified in Figure 5 have been applied in this model as follows:

- All sub-catchments located north of the point approximately 350 m upstream of the Victoria Road structure along Vineyard Creek were introduced into the model as total flows.

- The majority of the sub-catchments south of this point were applied to the model as local inflows, except for two sub-catchments located further upstream (see Figure 11).

6.2.8 Tailwater

Two tailwater scenarios have been examined for this modelling in order to account for potential coincident flooding between Vineyard Creek and Parramatta River flooding. These tailwater levels are:

- A mean sea level tailwater of 0 mAHD; and
- A 5% AEP tailwater that adopts the 5% AEP flood level for the model's downstream boundary from the Lower Parramatta River Flood Study (SKM, 2005).

6.2.9 Climate Change

Two climate change scenarios have been included as part of this modelling:

- RCP 4.5 – 2050
- RCP 4.5 – 2090

The tailwater increases for these scenarios have been adopted from Table 5 in the NSW DPE's *Understanding and Managing Flood Risk - Flood Risk Management Guideline FB01*.

Table 4: NSW Mean Sea Level Projections

Table 5 **IPCC *Sixth assessment report* (AR6) New South Wales mean sea level (MSL) projections to 2150 (in millimetres)**

	SSP2–4.5		SSP5–8.5	
Year	Median	Likely range [5% - 95%]	Median	Likely range [5% - 95%]
2020	54	[–1–114]	57	[5–113]
2030	100	[37–176]	108	[43–187]
2040	148	[74–250]	168	[92–274]
2050	212	[114–353]	247	[149–394]
2060	270	[148–456]	329	[199–533]
2070	341	[196–577]	430	[266–701]
2080	416	[244–707]	545	[346–888]
2090	486	[284–835]	678	[438–1,111]
2100	564	[331–983]	814	[523–1,342]
2110	645	[353–1,136]	920	[528–1,578]
2120	722	[392–1,281]	1,052	[605–1,811]
2130	797	[430–1,425]	1,178	[680–2,039]
2140	872	[466– 1,567]	1,297	[749– 2,263]
2150	945	[502–1,708]	1,408	[812–2,481]

Source: IPCC AR6 (Garner et al. 2021).

In August 2024, ARR Version 4.2 was released. Version 4.2 supersedes ARR 2019, and proposes a suite of changes to modelling approaches, with a significant change noted to Book 1, Chapter 6 'Climate Change Considerations'. The change recommends adjustment factors be applied to the ARR 2019 IFD design rainfall estimates to account for changes in climate and rainfall for present day conditions. The recommendation has effectively resulted in a third set of IFDs, which are referred to herein as ARR 2019 with Present Day Scaling (PDS) IFDs which are scaled to account for the expected temperature increase due to climate change for the year 2030 (based on the Current and near-term category in ARR 2019 for the years 2021-2040).

Hence the SSP2-4.5 in year 2030 scaling factor 1.11 was applied to the ARR19 IFD of this assessment. The rainfall was increased to represent the rainfall depth influenced by climate change in 2025.

Table 5: Extracted from ARR 2019 Datahub (Version 4.2)

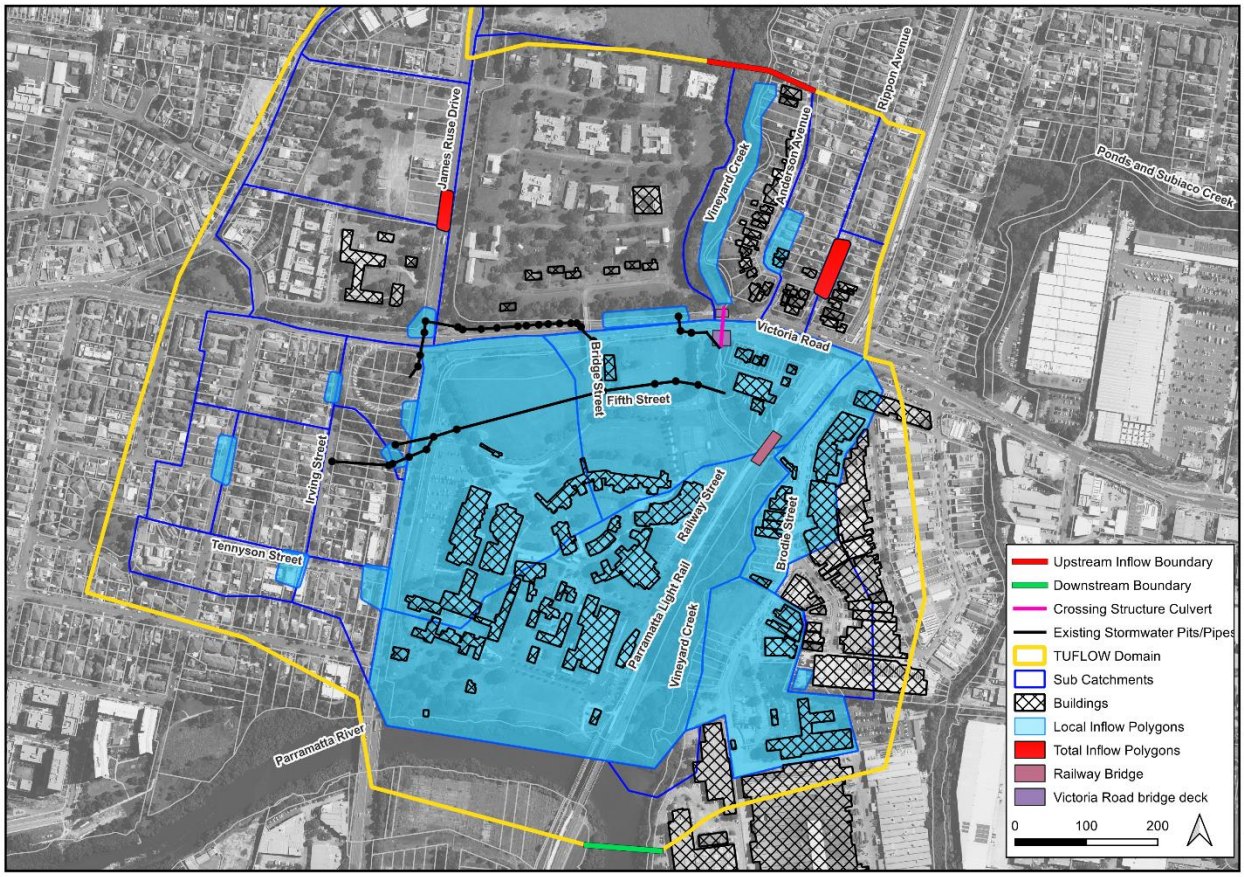
SSP2-4.5

Year	<1 hour	1.5 Hours	2 Hours	3 Hours	4.5 Hours	6 Hours	9 Hours	12 Hours	18 Hours	>24 Hours
2030	**1.18**	**1.17**	**1.16**	**1.14**	**1.13**	**1.12**	**1.12**	**1.11**	**1.1**	**1.1**
2040	1.22	1.2	1.19	1.17	1.16	1.15	1.14	1.13	1.12	1.12
2050	**1.27**	**1.24**	**1.23**	**1.21**	**1.19**	**1.18**	**1.17**	**1.16**	**1.15**	**1.14**
2060	1.3	1.27	1.25	1.23	1.21	1.2	1.19	1.18	1.16	1.16
2070	1.33	1.3	1.28	1.26	1.24	1.22	1.21	1.19	1.18	1.17
2080	1.37	1.33	1.31	1.28	1.26	1.24	1.22	1.21	1.2	1.19
2090	**1.4**	**1.36**	**1.34**	**1.31**	**1.28**	**1.26**	**1.24**	**1.23**	**1.21**	**1.2**
2100	1.41	1.37	1.35	1.32	1.29	1.27	1.25	1.24	1.22	1.21

6.2.10 TUFLOW Model Setup

The TUFLOW Model Setup for this project is documented in Figure 11.

Figure 11: TUFLOW Model Setup



6.3 Model Results and Verification

A full series of hydrological events – with varying storm durations and temporal patterns – were modelled in GRC's 2D hydraulic model (Existing Condition scenario) to determine the critical 1% AEP event for the site.

These events were as follows:

Durations:	60 minutes, 90 minutes, 120 minutes, 360 minutes, 540 minutes and 720 minutes
Temporal Pattern:	TP01, TP02, TP03, TP04, TP05, TP06, TP07, TP08, TP09 and TP10

The critical duration selected for the 1% AEP event was 720 minutes (12 hours) with the TP06 temporal pattern.

The critical durations selected for all design events were as follows:

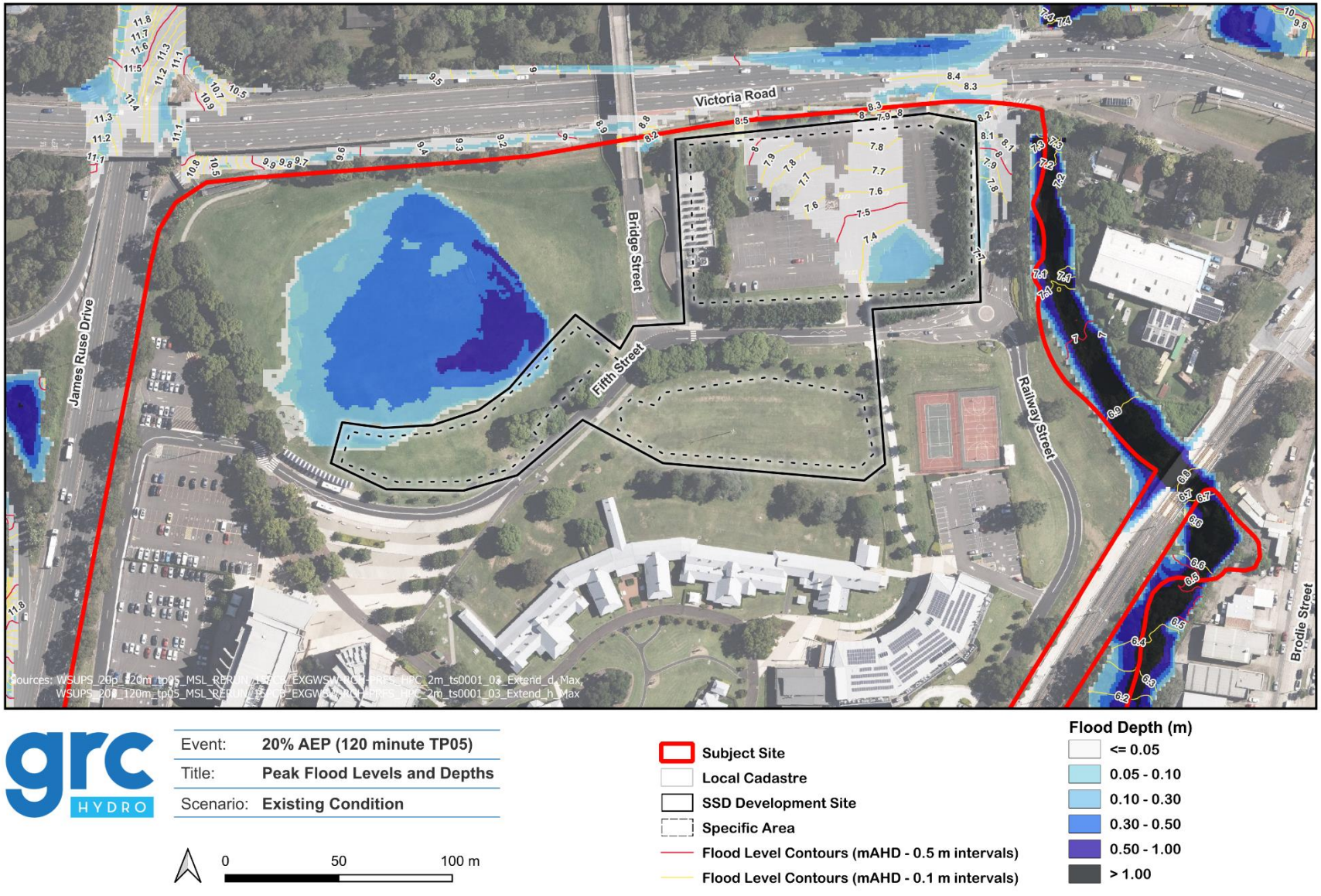
20% AEP	120 minutes (2 hours)- TP05	Flow: 17.3 m^3/s
5% AEP	180 minutes (3 hours)- TP04	Flow: 24.8 m^3/s
1% AEP	720 minutes (12 hours)- TP06	Flow: 40.3 m^3/s
1% AEP + RCP 4.5 2050*	720 minutes (12 hours)- TP06	Flow: 45.1 m^3/s
1% AEP + RCP 4.5 2090*	720 minutes (12 hours)- TP06	Flow: 46.7 m^3/s
0.2% AEP	90 minutes (1.5 hours) – TP05	Flow: 45.6 m^3/s
PMF	45 minutes – TP01	Flow: 357 m^3/s

* These Climate Change scenarios have incorporated rainfall increases as per Table 4 of the NSW DPE's Understanding and Managing Flood Risk- Flood Risk Management Guideline FB01.

6.3.1 Existing Condition

Modelling results for the Existing Condition for the 20% AEP, 5%AEP, 1% AEP, 0.2% AEP and PMF design events are documented below in Figures 12 to 32 below.

Figure 12: Peak Flood Levels and Depths – 20% AEP – Existing Condition



Event:	**20% AEP (120 minute TP05)**
Title:	**Peak Flood Levels and Depths**
Scenario:	**Existing Condition**

0 50 100 m

Subject Site
Local Cadastre
SSD Development Site
Specific Area
Flood Level Contours (mAHD - 0.5 m intervals)
Flood Level Contours (mAHD - 0.1 m intervals)

Flood Depth (m)
- **<= 0.05**
- **0.05 - 0.10**
- **0.10 - 0.30**
- **0.30 - 0.50**
- **0.50 - 1.00**
- **> 1.00**

Figure 13: Flood Velocity and Hazard – 20% AEP – Existing Condition

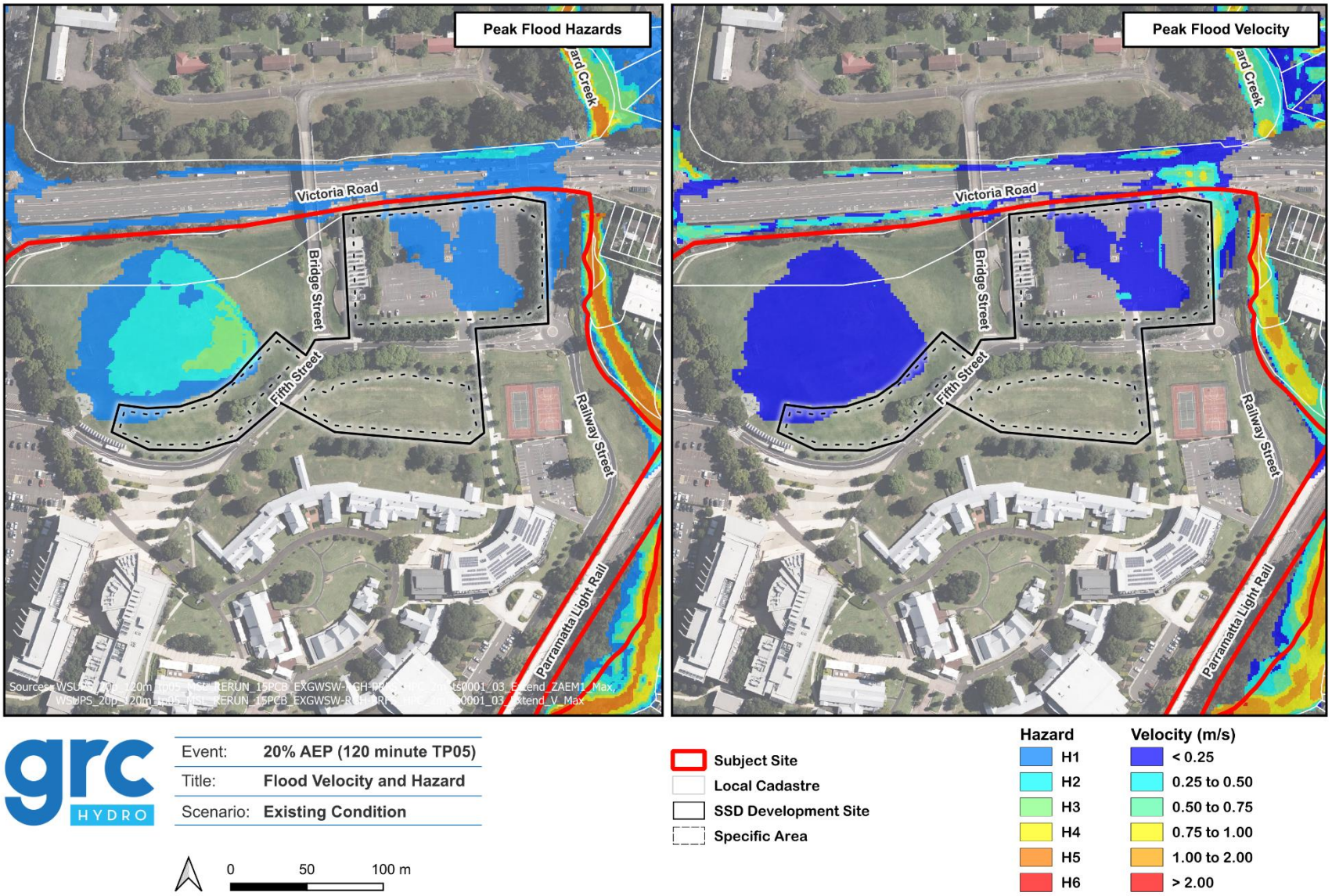


Figure 14: Peak Flood Levels and Depths – 5% AEP – Existing Condition

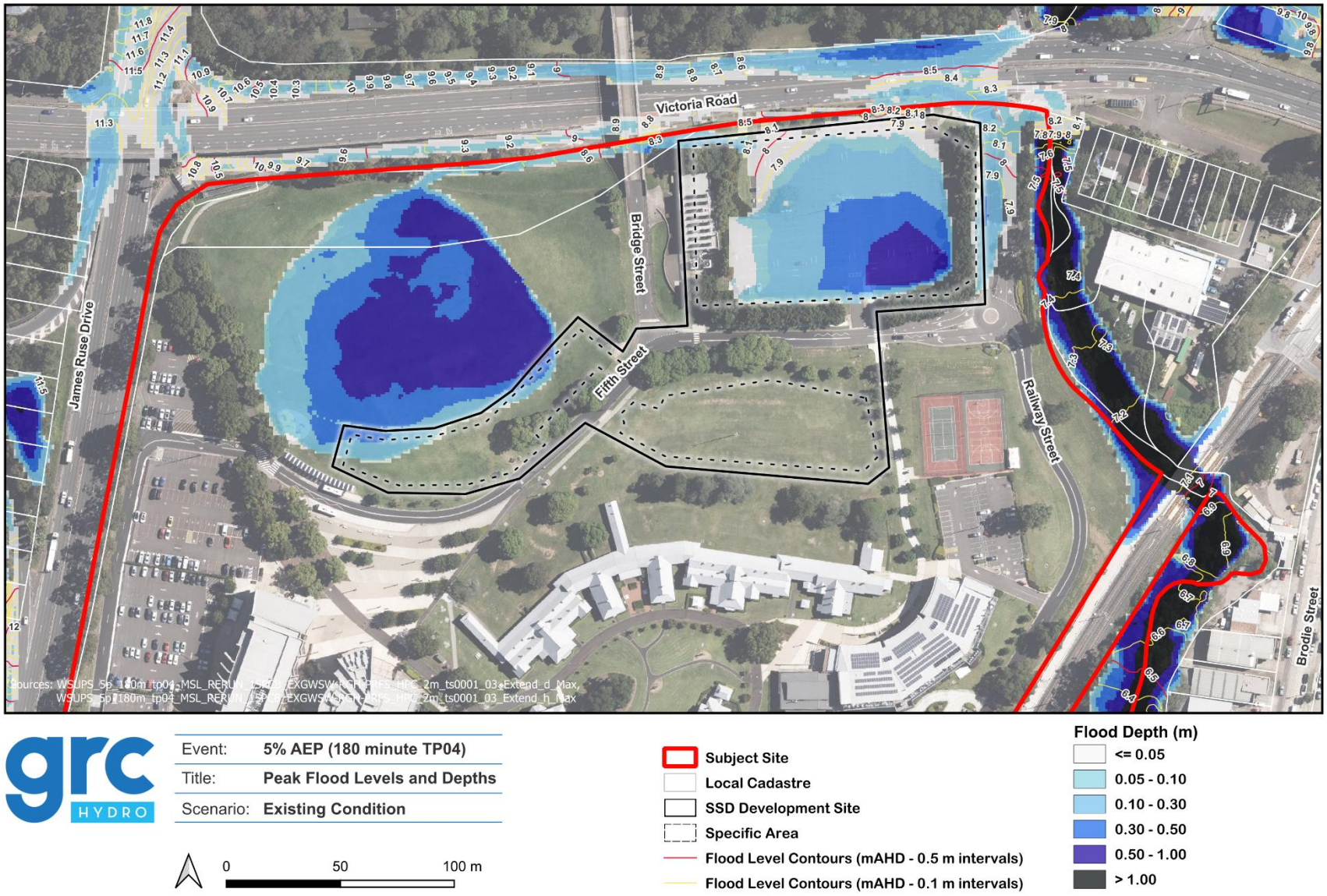


Figure 15: Flood Velocity and Hazard – 5% AEP – Existing Condition

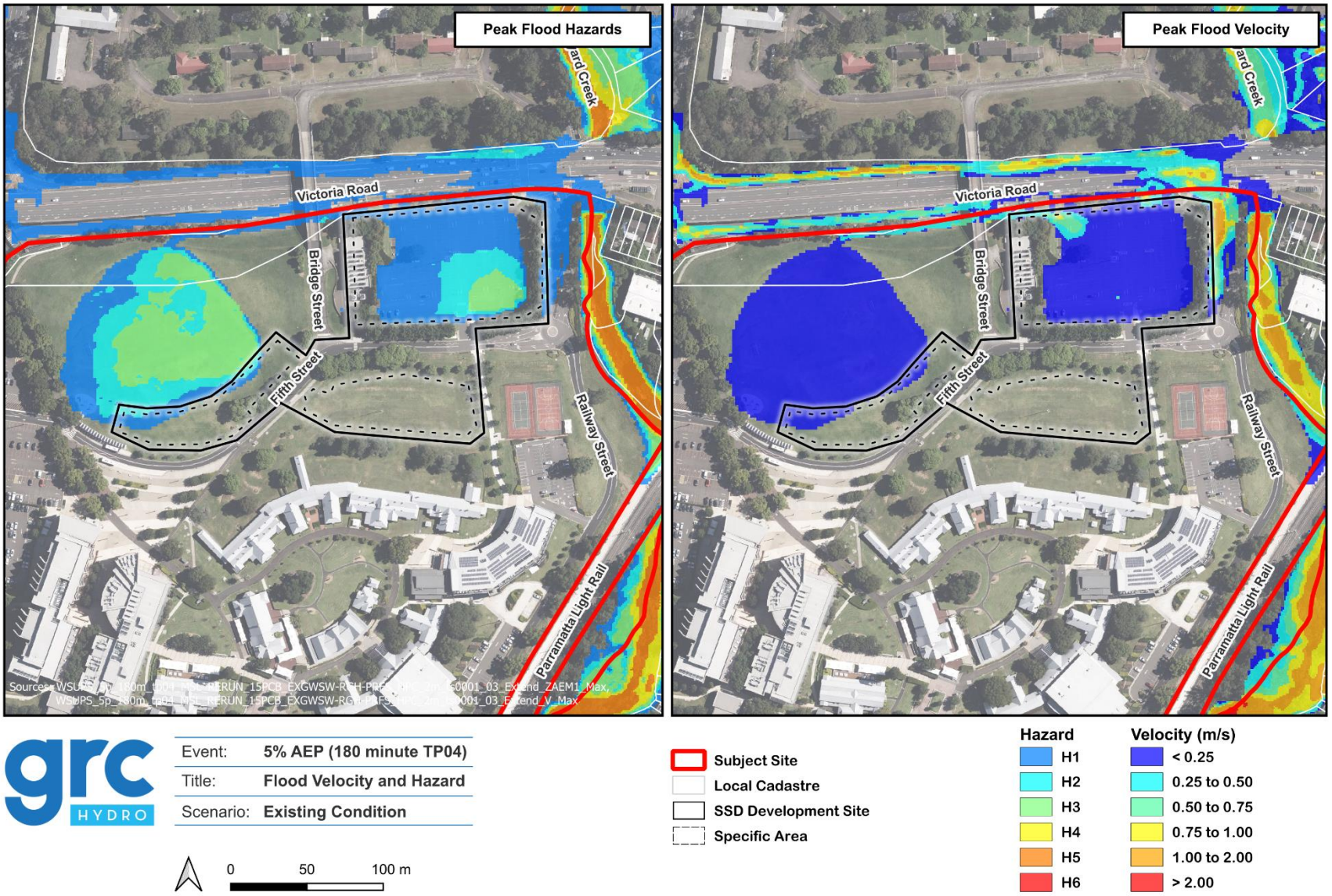


Figure 16: Peak Flood Levels and Depths – 1% AEP – Existing Condition

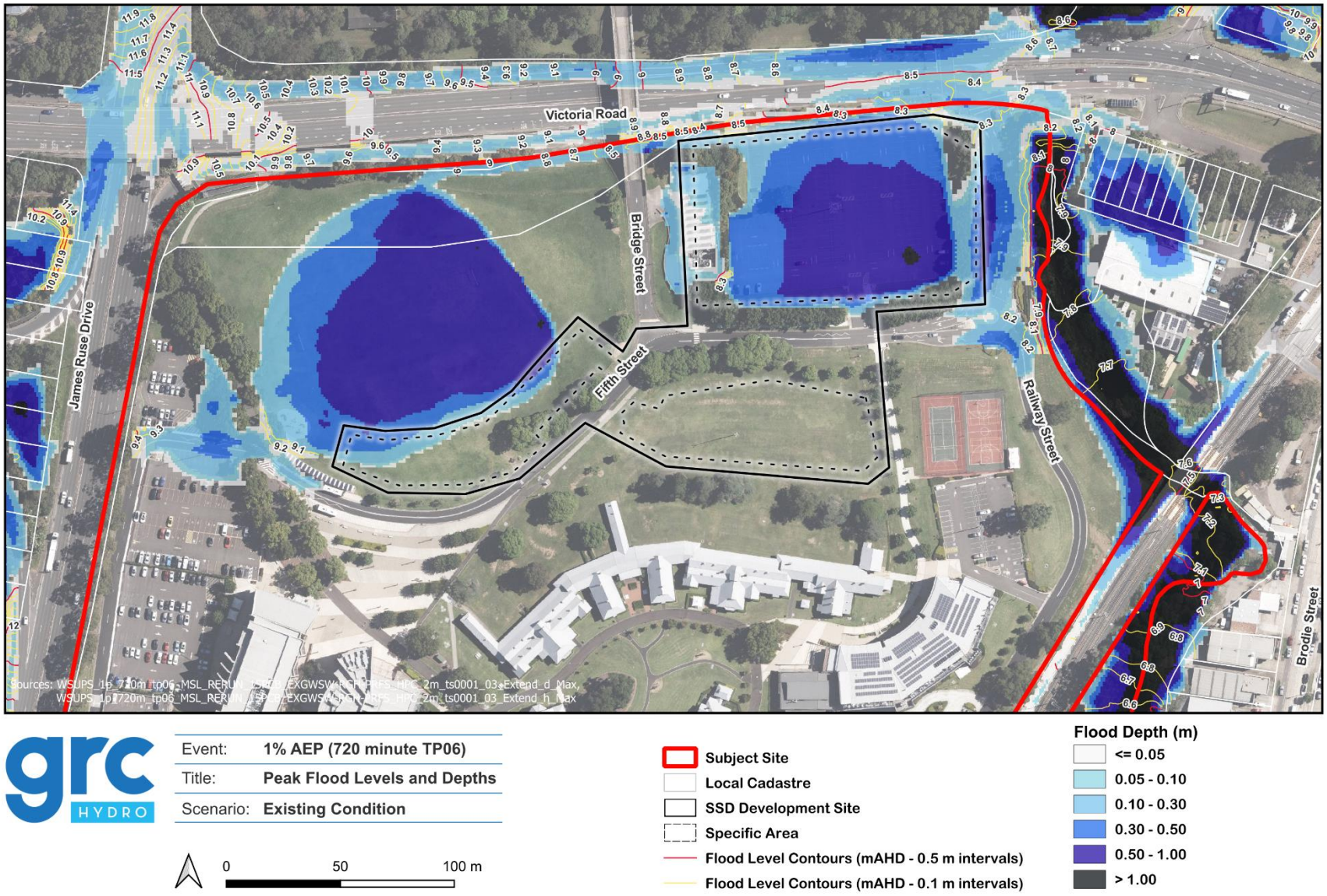


Figure 17: Flood Velocity and Hazard – 1% AEP – Existing Condition

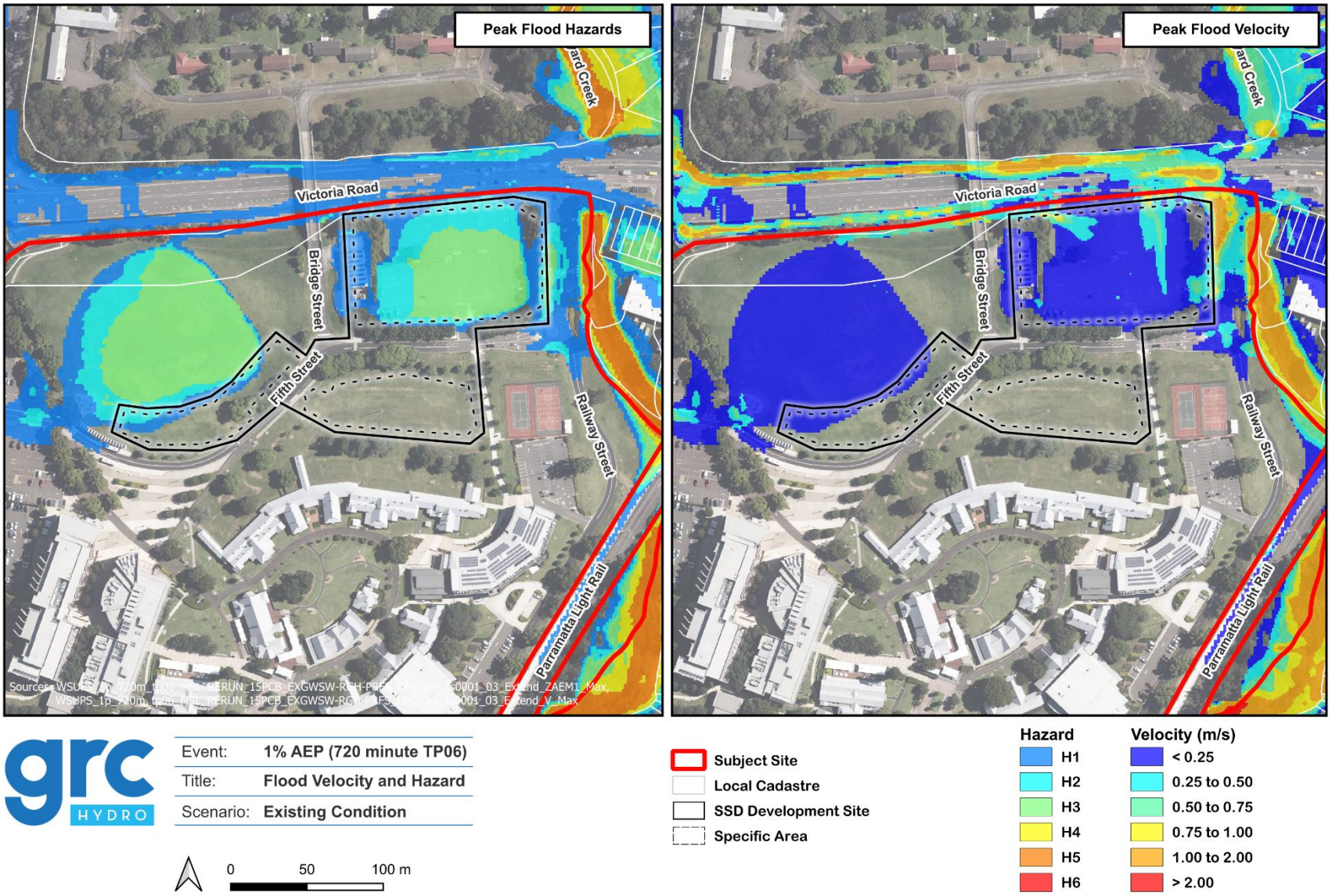


Figure 18: Flood Function – 1% AEP – Existing Condition

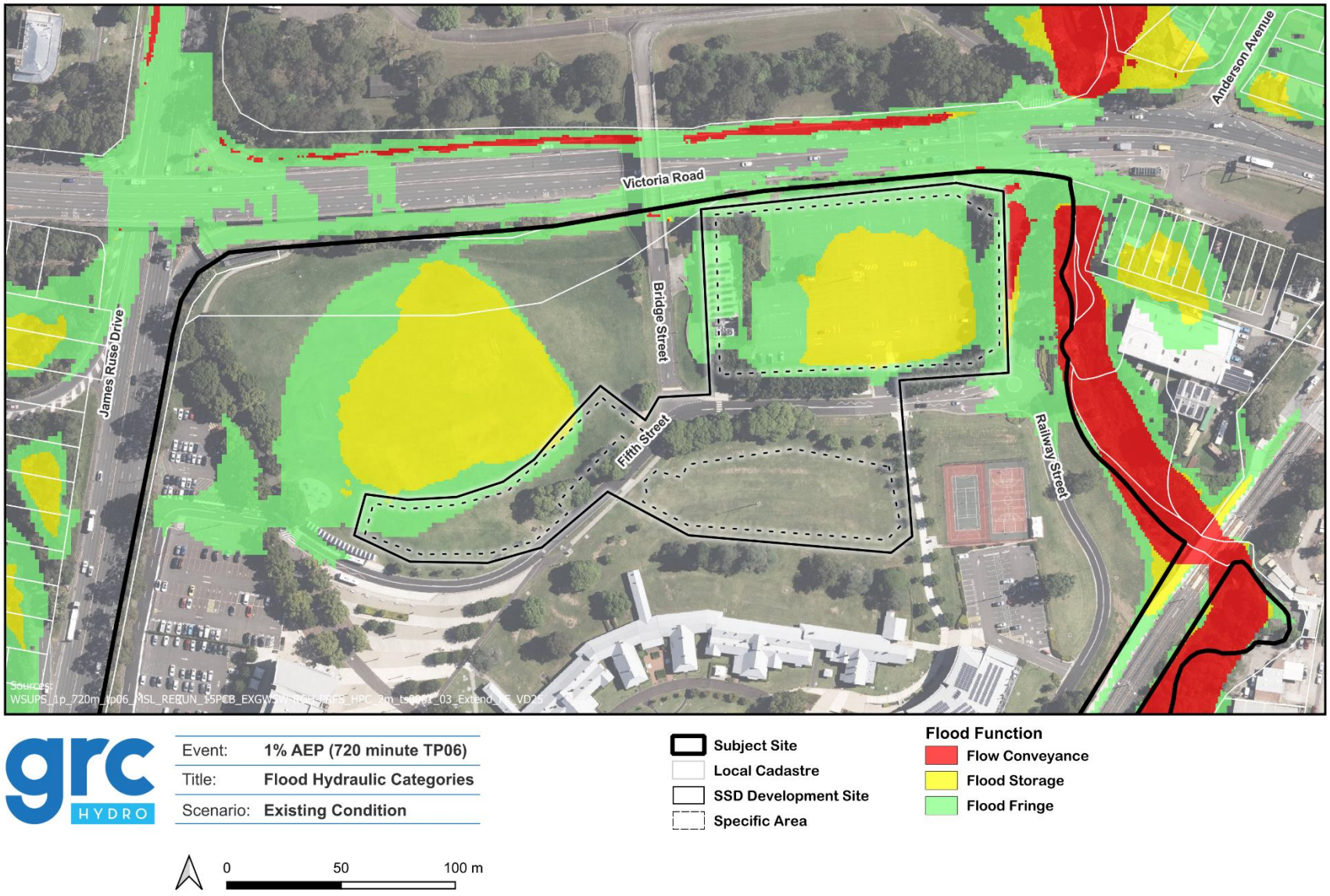


Figure 19: Flood Level Impact Sensitivity Analysis – 1% AEP – Existing Condition (50% Blockage minus No Blockage)

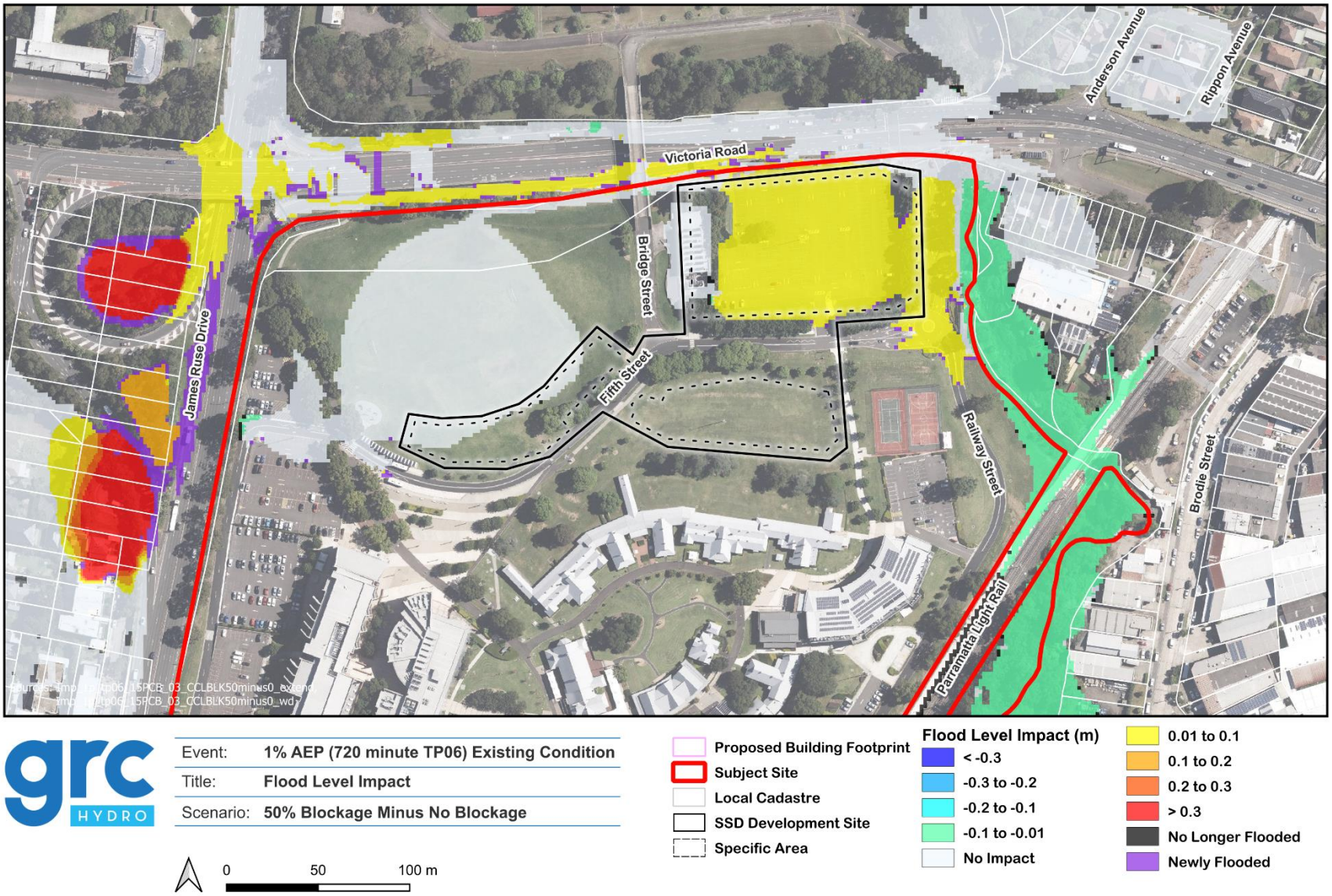


Figure 20: Flood Level Impact Sensitivity Analysis – 1% AEP – Existing Condition (100% Blockage minus No Blockage)

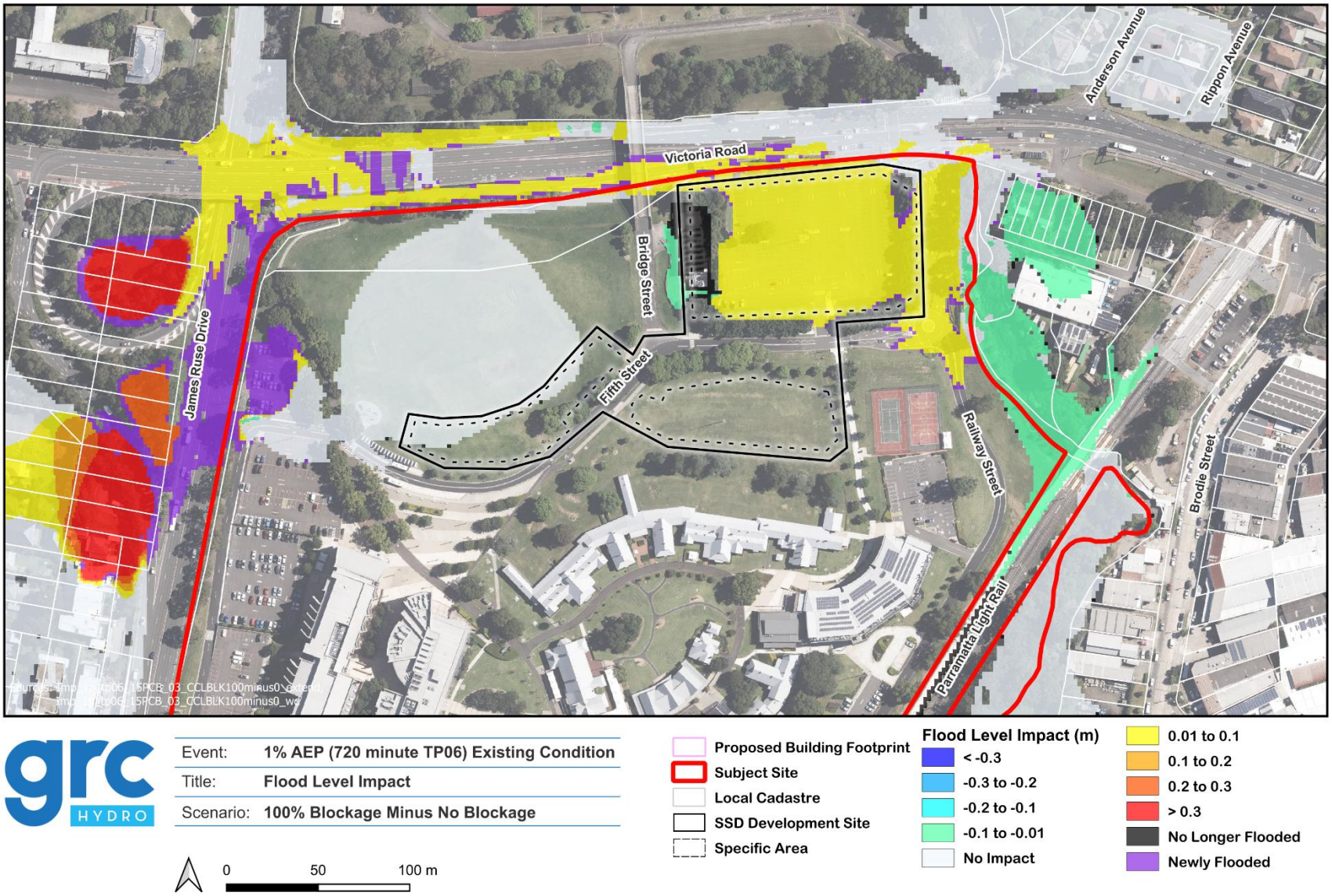
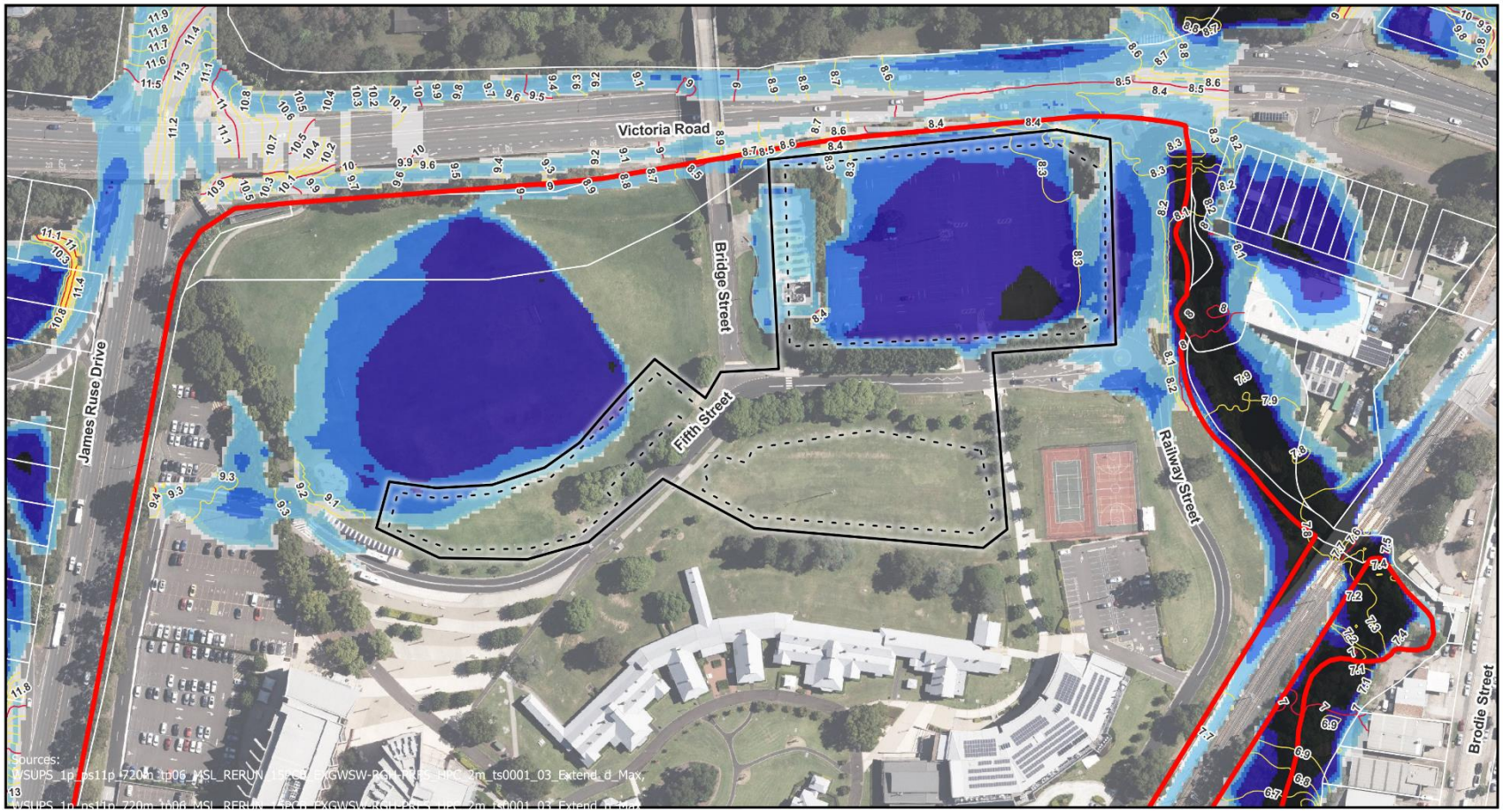


Figure 21: Peak Flood Levels and Depths – 1% AEP (present-day scaling rainfall loading) – Existing Condition



Event:	**1% AEP x1.11 (720 minute TP06)**
Title:	**Peak Flood Levels and Depths**
Scenario:	**Existing Condition**

0 50 100 m

- Subject Site
- Local Cadastre
- SSD Development Site
- Specific Area
- Flood Level Contours (mAHD - 0.5 m intervals)
- Flood Level Contours (mAHD - 0.1 m intervals)

Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Figure 22: Flood Velocity and Hazard – 1% AEP (present-day scaling rainfall loading) – Existing Condition

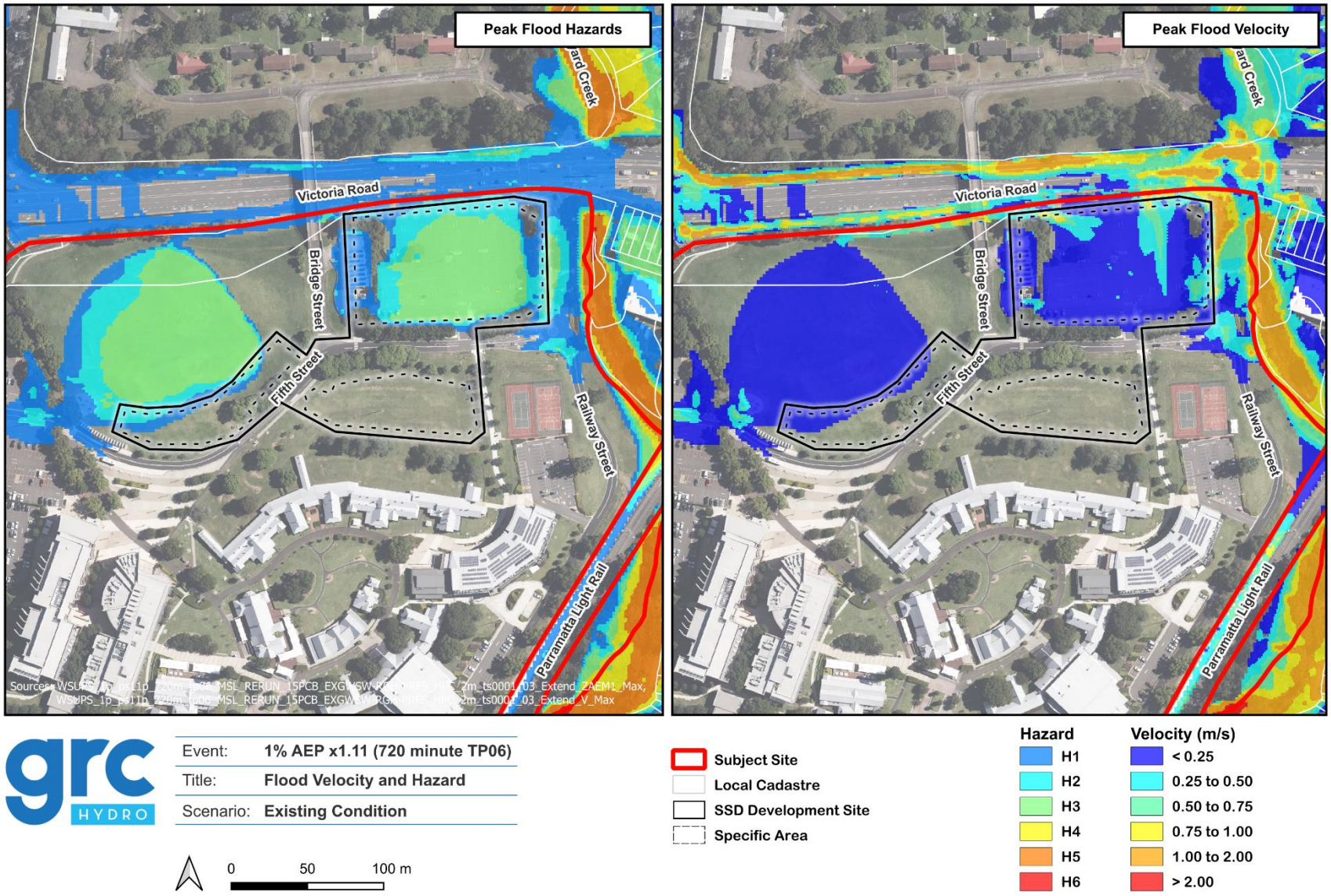


Figure 23: Peak Flood Levels and Depths – 1% AEP (with additional 19% rainfall loading) – Existing Condition

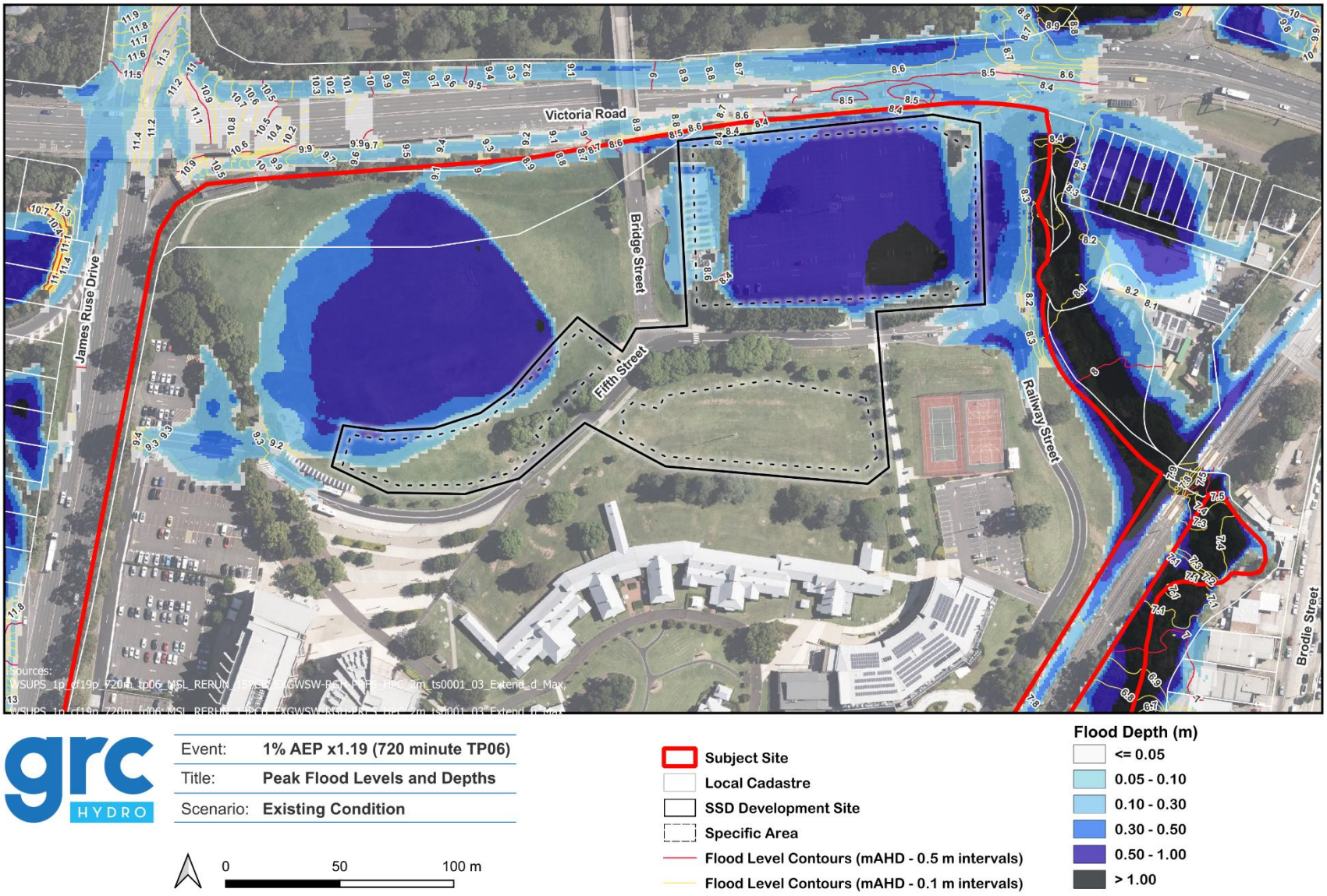


Figure 24: Flood Velocity and Hazard – 1% AEP (with additional 19% rainfall loading) – Existing Condition

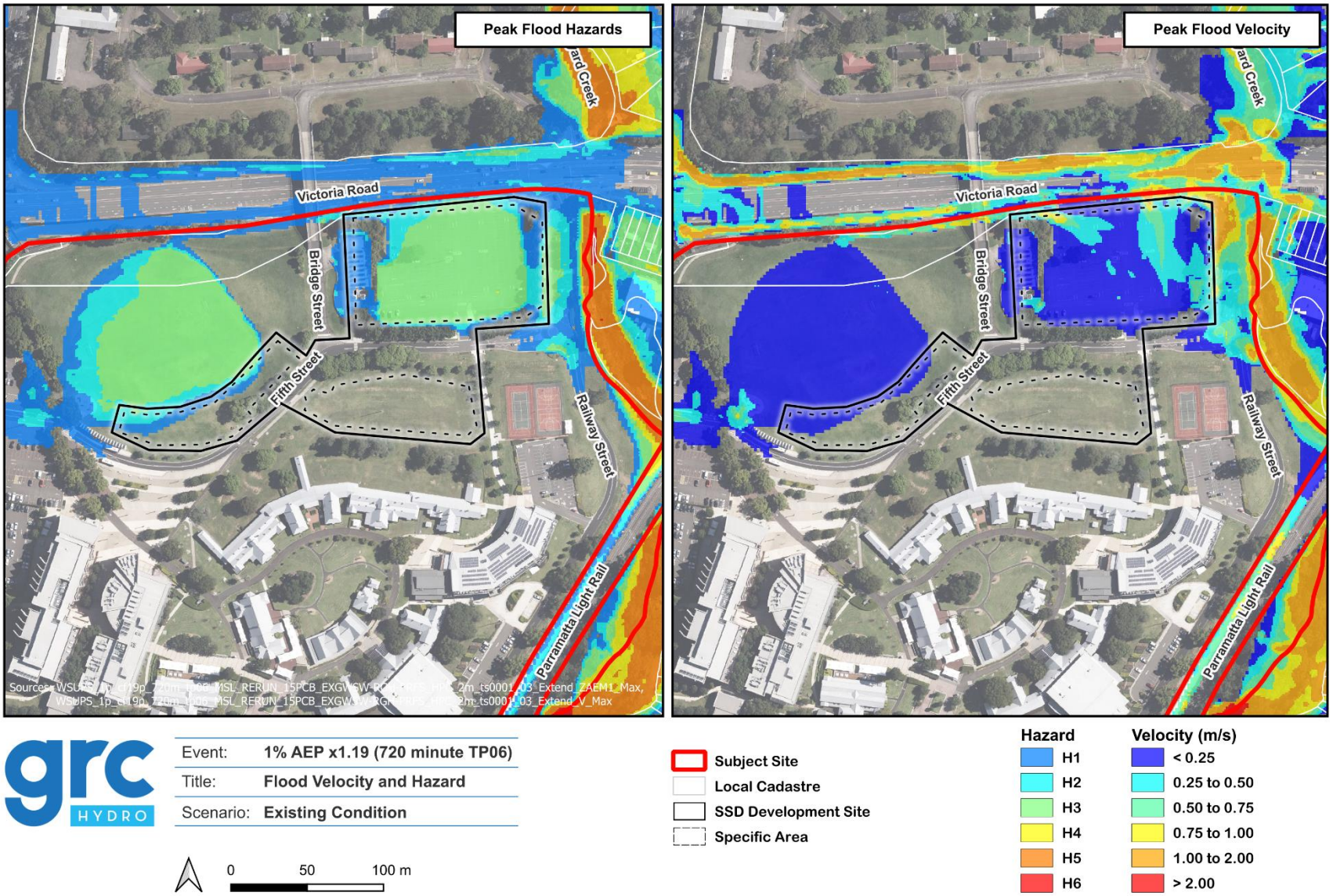


Figure 25: Peak Flood Levels and Depths – 1% AEP with Climate Change (RCP 4.5 2050) – Existing Condition

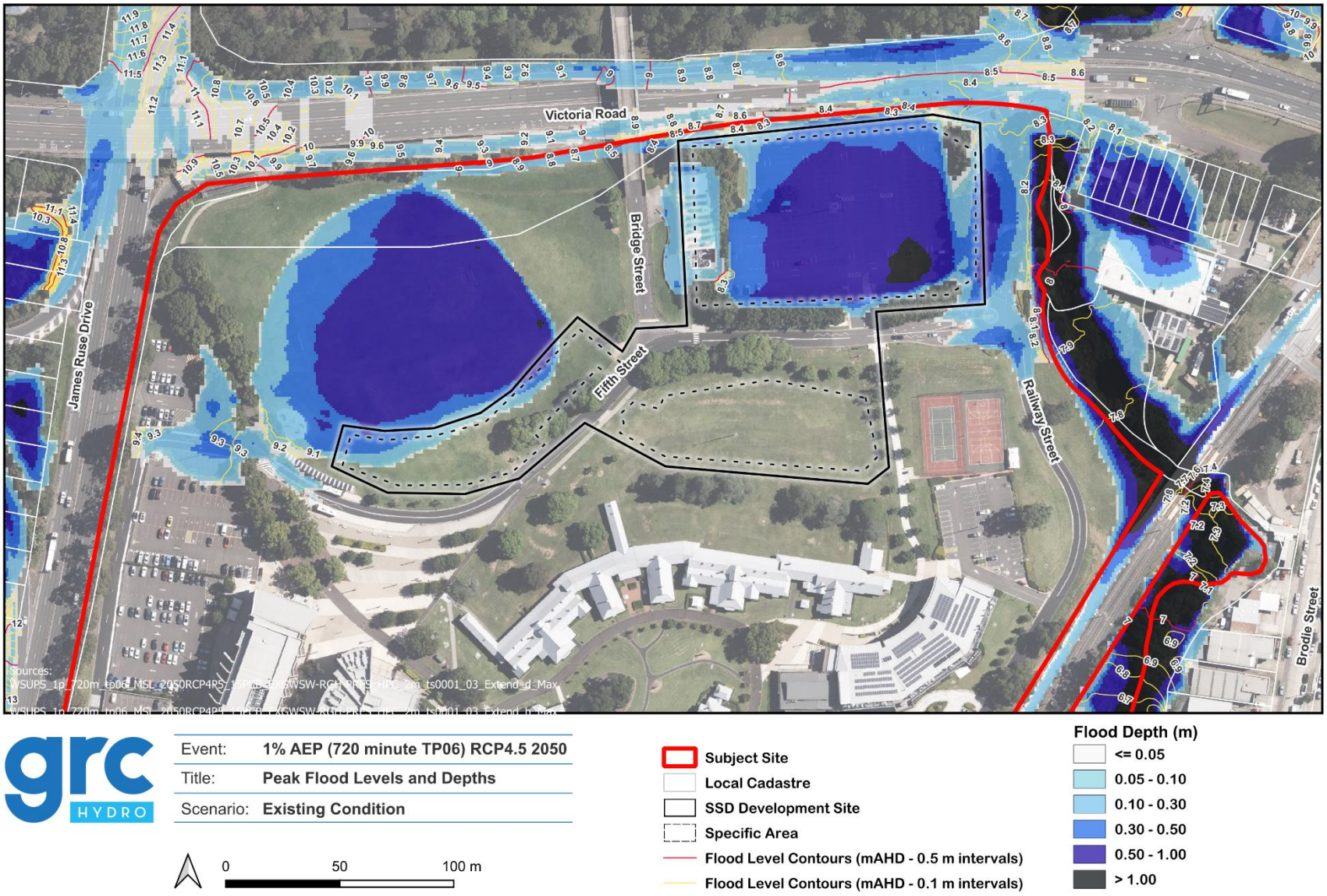


Figure 26: Flood Velocity and Hazard – 1% AEP with Climate Change (RCP 4.5 2050) – Existing Condition

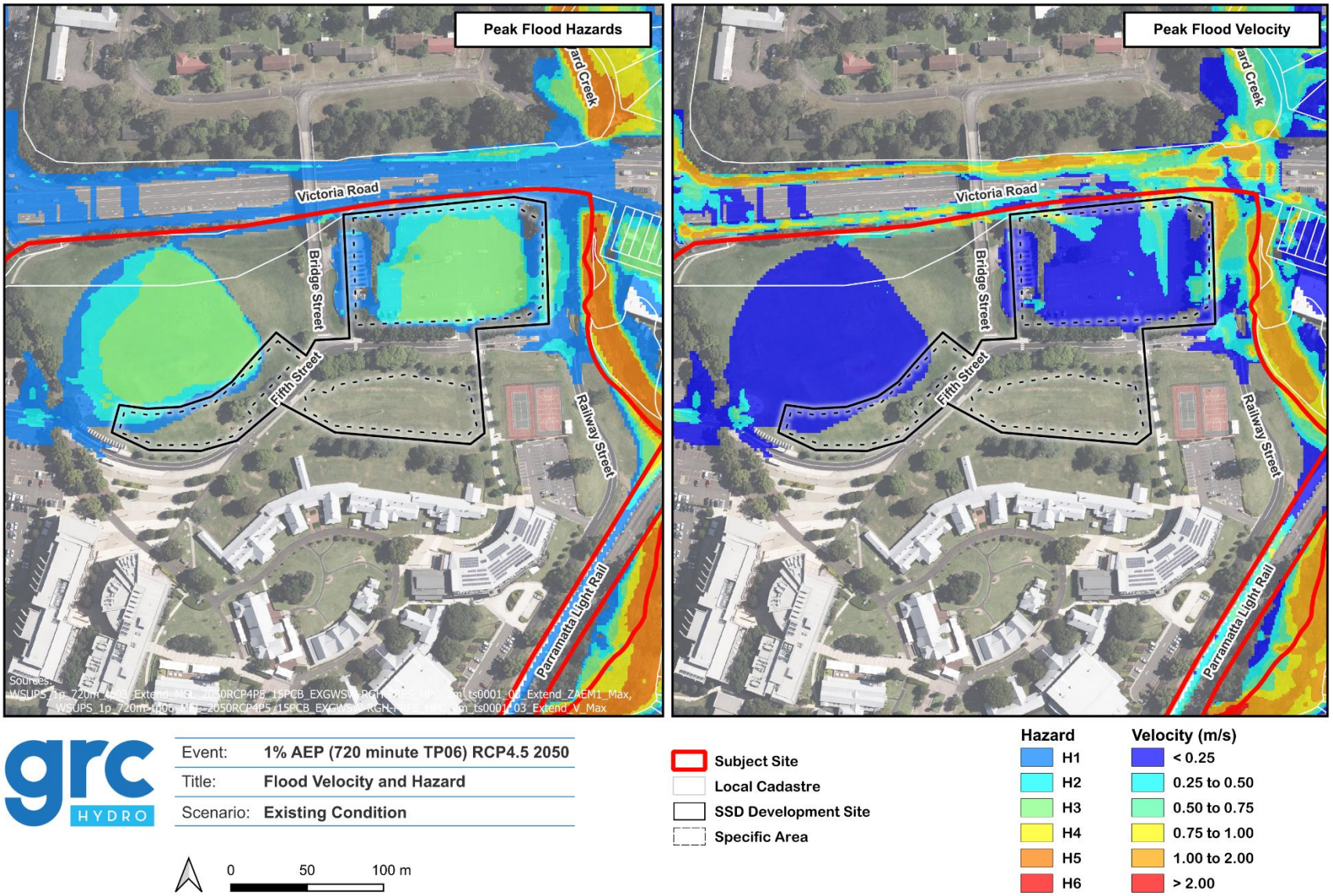


Figure 27: Peak Flood Levels and Depths – 1% AEP with Climate Change (RCP 4.5 2090) – Existing Condition

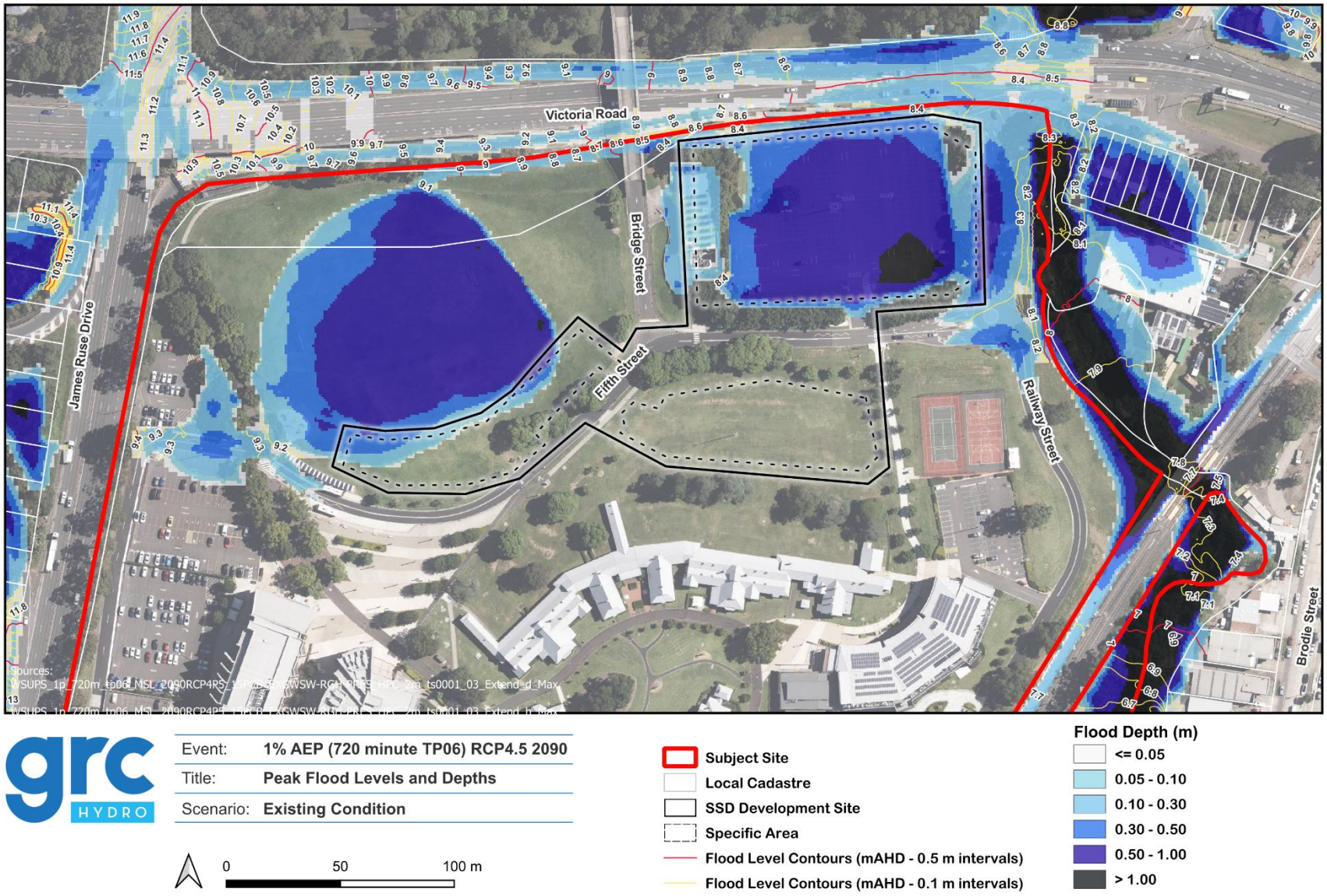


Figure 28: Flood Velocity and Hazard – 1% AEP with Climate Change (RCP 4.5 2090) – Existing Condition

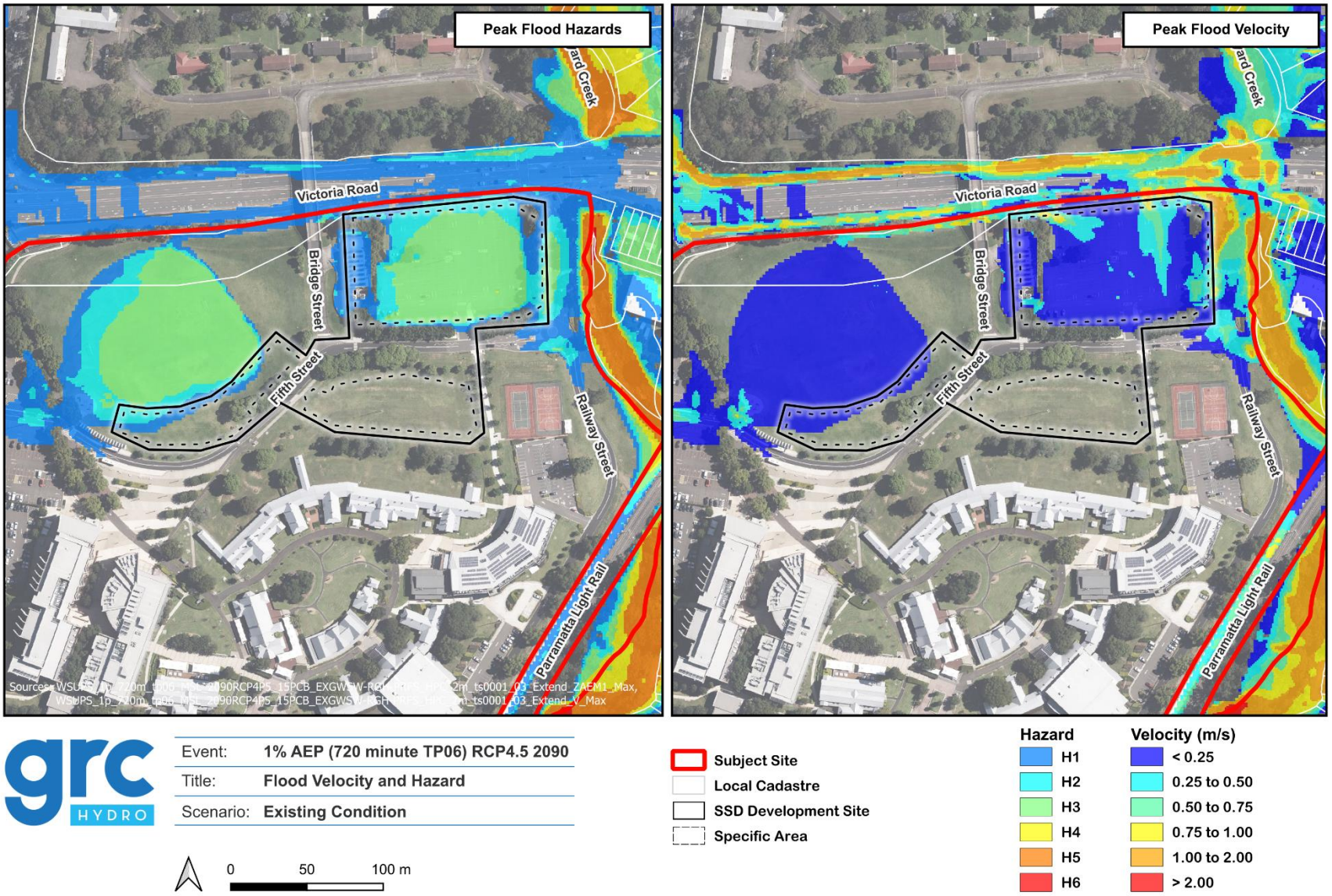


Figure 29: Peak Flood Levels and Depths – 0.2% AEP – Existing Condition

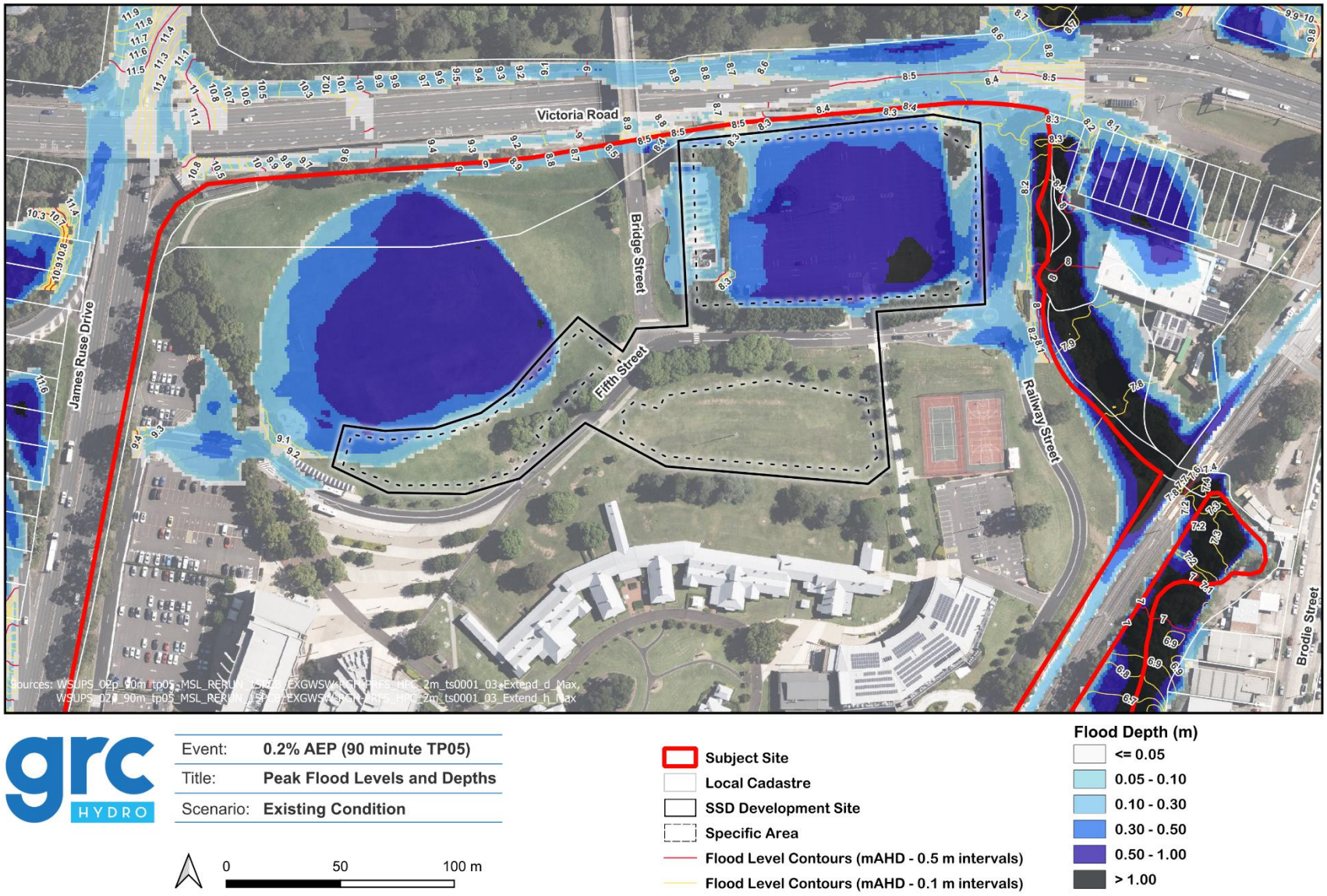


Figure 30: Flood Velocity and Hazard – 0.2% AEP – Existing Condition

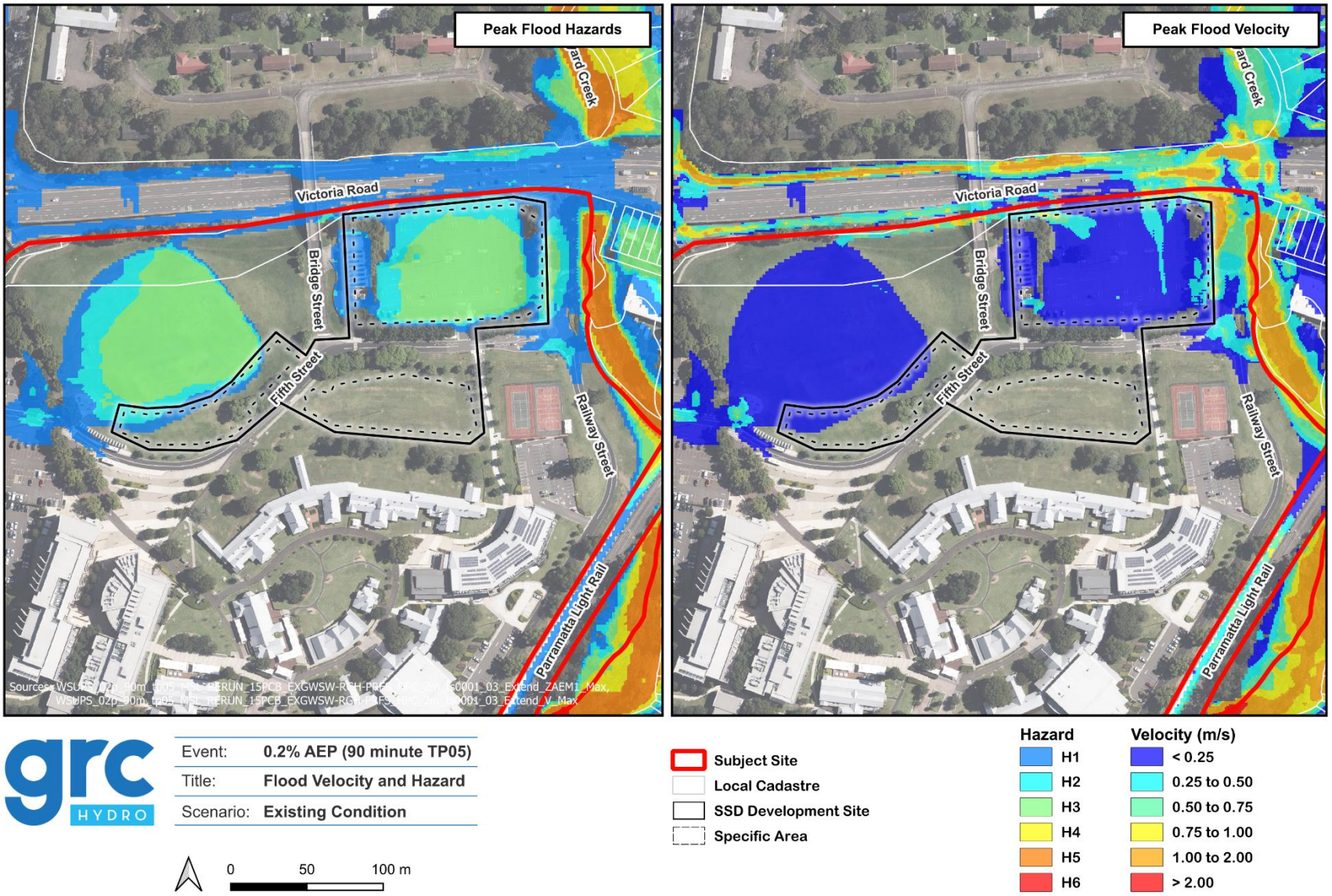


Figure 31: Peak Flood Levels and Depths – PMF – Existing Condition

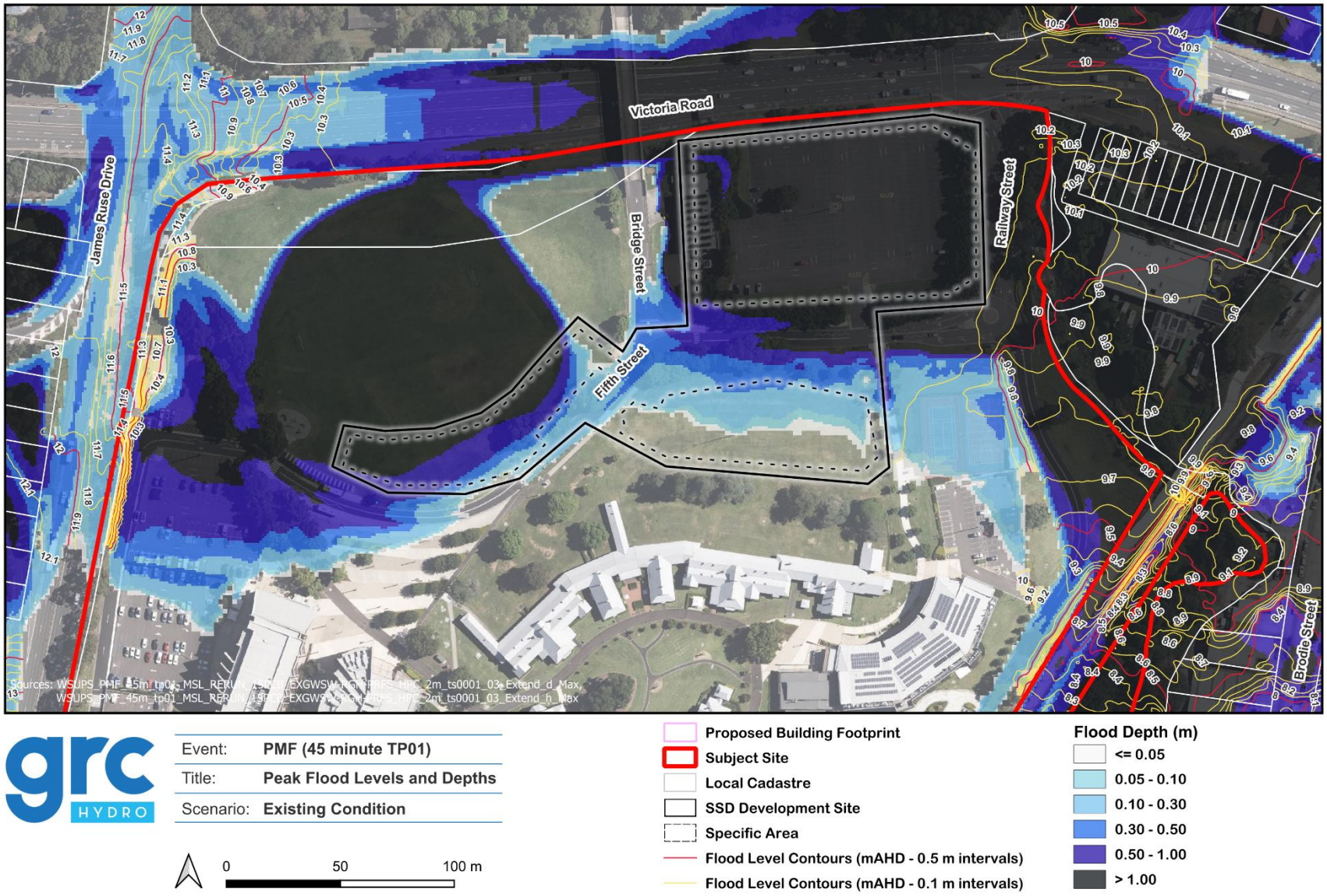
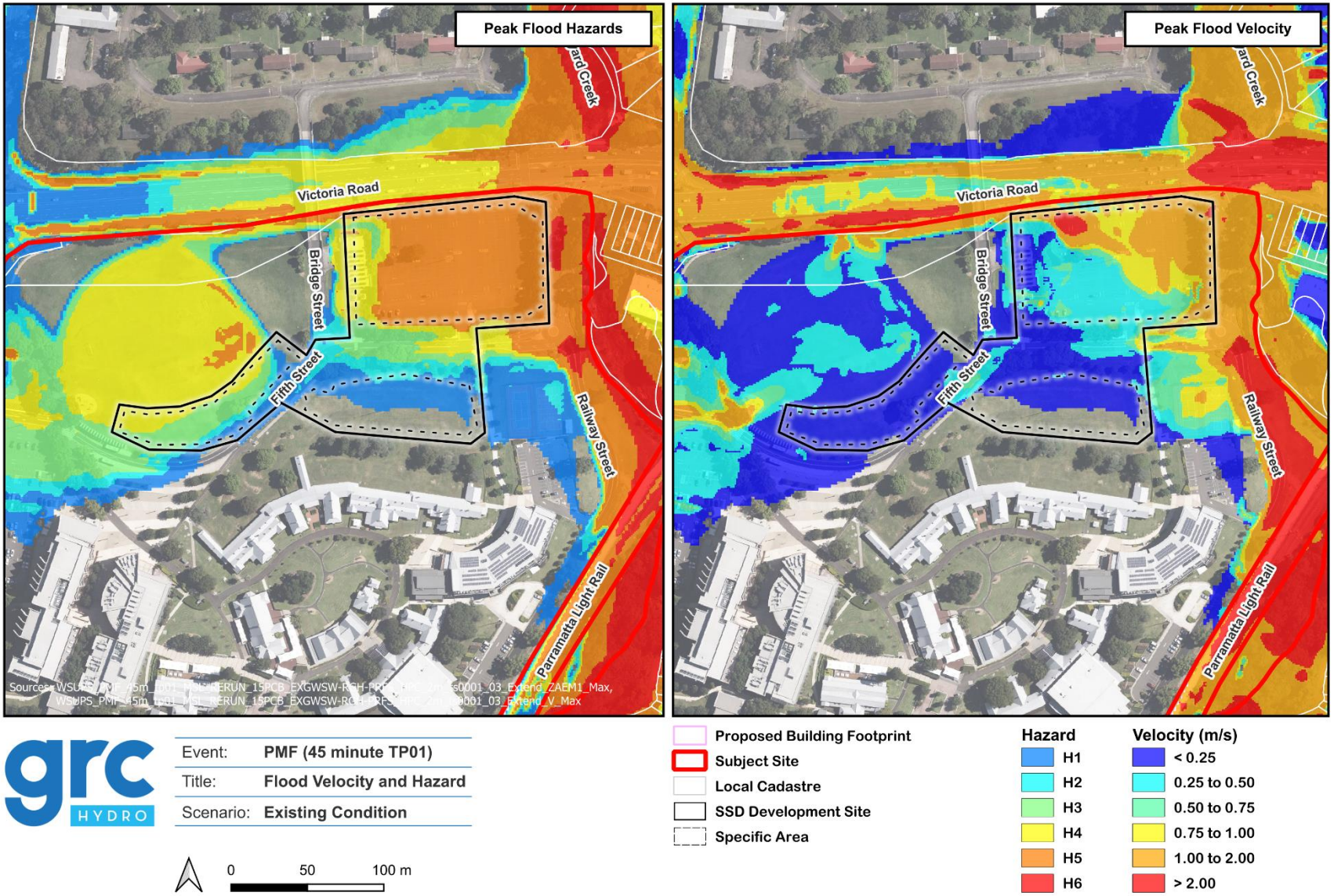


Figure 32: Flood Velocity and Hazard – PMF – Existing Condition



6.3.2 Comparison of Modelled Existing Levels to Council Flood Levels

The modelled flood level at the site in the 1% AEP event is 8.3 mAHD (see Figure 16). The flood certificate does not provide a comparable level at the subject site, however the Vineyard Creek flood levels documented on the Council-provided flood map (see Figure 4) appear to be a good match with GRC's 1% AEP estimate (see Figure 16) in that:

- in both sets of results the site is flooded in the 1% AEP;
- in the SKM 2005 results, the level upstream of Victoria Road is 8.6 mAHD which is similar to GRC's modelled level of 8.5 mAHD; and
- in the creek immediately downstream of Victoria Road, the SKM 2005 levels of 8.0 mAHD are approximately matched by GRC's modelling with slightly higher values of approximately 8.1 mAHD in this location (see Figure 16).

SMEC 2004 flood level estimates are higher than GRC's estimates. SMEC 2004 flood level estimates are 9.0 mAHD upstream of Victoria Road and approximately 8.5 mAHD in the downstream reach of Vineyard Creek. GRC were unable to determine how the SMEC 2004 estimates came to be and given they exceed the ARR2019 0.2% AEP design level estimates at the site, we conclude they may constitute an exaggeration. It is speculation but given the 2004 estimate was done in Mike-11 (a modelling package), the extreme levels could be the result of limited cross-section width meaning that the entire floodplain was not available for flow and storage.

GRC's modelling is deemed to be acceptable for use on the following basis:

- Best practice has been followed- Given that the modelling tools available in 2024 have progressed since the SKM and SMEC studies were originally conducted, and as the hydrological and hydraulic modelling conducted for this study represents current best practice, GRC believe that the 1% AEP flood level of 8.3 mAHD is a reliable estimate;
- GRC's work uses a 12-hour critical duration in the 1% AEP and this is conservative as in truth the 12-hour event temporal patterns contain embedded bursts which mean rainfall is rarer than the 1% AEP;
- GRC's modelled 1% AEP flood levels are a reasonable match with the latest design levels Council's flood certificate refers to (SKM, 2005);
- Flood level sensitivity is not high as the 0.2% AEP design flood estimate has levels only slightly higher than the 1% AEP design flood estimate;
- The use of a 500 mm freeboard at the subject site implies a high level of protection from flooding and as per the Manual incorporates a suitable factor of safety. This is particularly the case when we look at the over bank conditions for Vineyard Creek at Victoria Road (wide and flat overbank will tend to mean minimal increases in flood level relative to flow increase); and finally
- In adopting an FFL of 9.0 mAHD (whereas arguably 8.8 mAHD only is required), and a design that is flood compatible (allows through flow and doesn't seek to block site), the proposed works reduce the flood risk impact of site inundation.

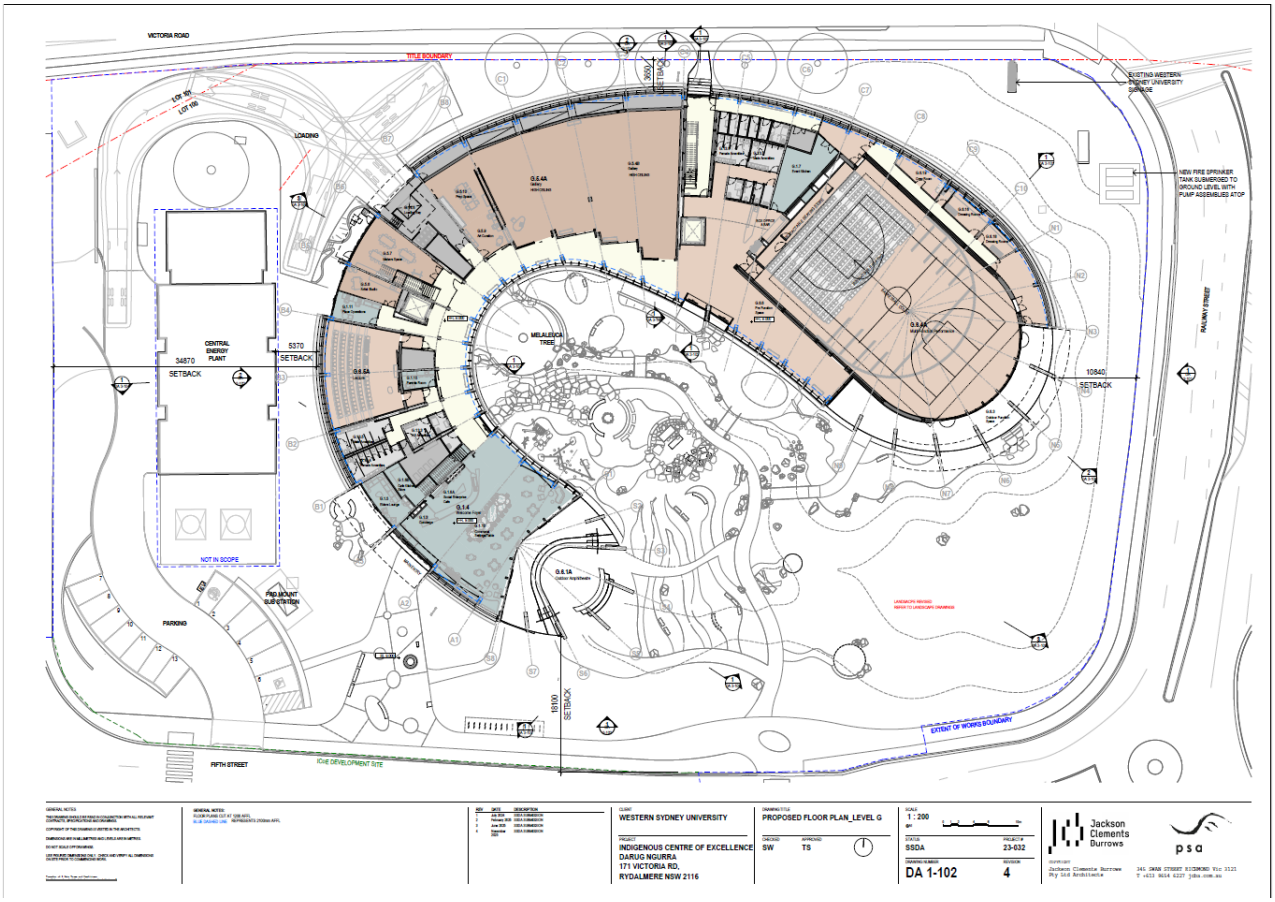
6.3.3 Flood Planning Level

With a 1% AEP flood level at site of 8.49 mAHD and given the requirement for 500 mm of freeboard the Flood Planning Level (FPL) for this development is 8.99 mAHD. The proposed development has a finished floor level of 9.0 mAHD.

6.3.4 Proposed Development

The proposed development consists of:

- The regrading of the existing car park to facilitate landscaping and the proposed development (as per the surface provided by TTW on 24/11/2025; and
- The development of a culturally-significant educational facility (the Indigenous Centre of Excellence)
- A car parking facility to the south and south-west of the ICoE (Drawings provided by TTW in November 2024: 234338-TTW-01-DR-CI-0XXXX-P2-Combined.pdf and ACAD-234338 BS CARPARK GDA2020.dwg)



6.3.5 Proposed Condition

Modelling results for the proposed condition for the 20% AEP, 5%AEP, 1% AEP, 0.2% AEP and PMF design events are documented below from Figures 33 to 62.

6.3.6 Flood Level Impact

The modelled flood level impact is documented in the figures below. The proposed design modifies the land in a way that aggregates flood waters into a smaller footprint than in the existing case. This is the result of the introduction of water sensitive landscaping (excavation and reforming) in the eastern and south-eastern portion of the site.

The proposed development and regrading results in a generally positive flood level impact. Any minor adverse impacts are restricted to the subject site and does not cause flood impacts for surrounding properties and some adjacent areas are predicted to experience less flooding.

Broadly what we see is that the proposed works make it easier for flow across Victoria Road (i.e. water that does not continue to flow downstream in Vineyard Creek) to more efficiently enter the site. As such we see reductions in 1% AEP flood levels on Victoria Road at the subject site's northern boundary.

6.3.7 Cumulative Impact Associated with Car Park Development

GRC conducted a flood assessment for the proposed car park to the south of the proposed ICoE. This development is to be constructed largely on grade, with limited change to the existing elevations. The proposed car park footprint also has limited overlap with the flood extent (PRFS 2024).

The proposed car park is to consist of a combination of bitumen access roads and parking spaces with a turf cell surface so the potential impact of introducing hardstand to this area upstream of the ICoE is limited.

The car park flood assessment was developed on the basis that the car park was to be constructed of bitumen but the recent amendment to construct car spaces using turf cells poses no material difference to the assessment and the ICoE site.

The proposed car park terrain has been included in the updated modelling for the proposed case.

6.3.8 Comparison of Pre-Development and Post Development Flows

The City of Parramatta requested the following flow comparison:

Provide a table with comparison of Pre-Development and Post Development Flows (Pipe Flow, Overland Flow and combined pipe & overland flow) leaving the site at each of the locations. Discharge should be less than pre-development flows

This has been provided below:

Location	1% AEP (Present-day Scaling)		PMF	
	Pre-Development (m^3/s)	Post Development (m^3/s)	Pre-Development (m^3/s)	Post Development (m^3/s)
Overland Flow A	0.8	0.7	22.7	14.1
Overland Flow B	2.1	2.1	33.2	22.6
Overland Flow C	2.8	2.8	94.1	94.1
Pipe Inflow A	1.3	1.3	1.4	1.4
Pipe Inflow B	1.4	1.3	1.3	1.4
Total Inflow	**8.4**	**8.2**	**152.7**	**133.6**
Overland Outflow A	3.6	3.5	63.5	58.0
Overland Outflow B	1.4	1.4	50.0	43.5
Pipe Outflow A	3.0	3.0	4.1	4.0
Total Outflow	**8.0**	**7.9**	**117.6**	**105.5**

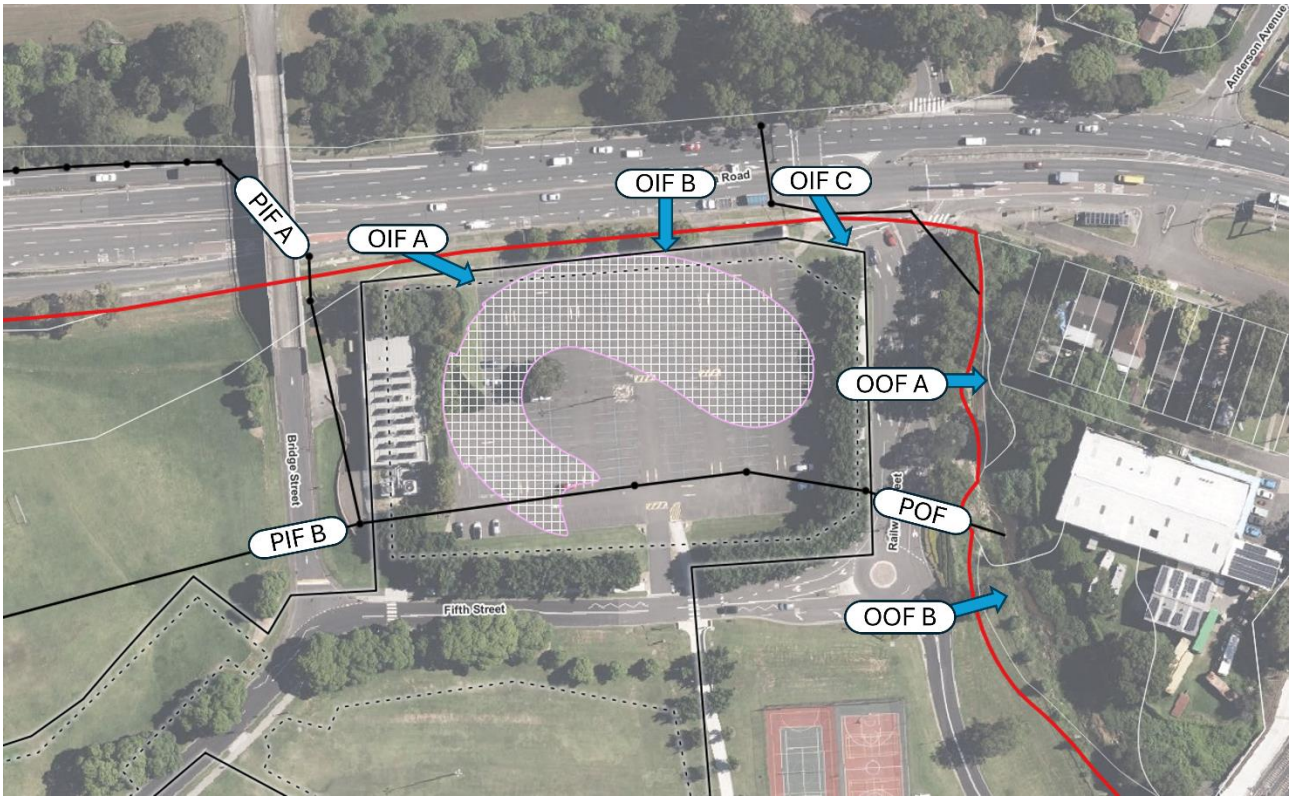


Figure 33: Peak Flood Levels and Depths – 20% AEP – Developed Condition

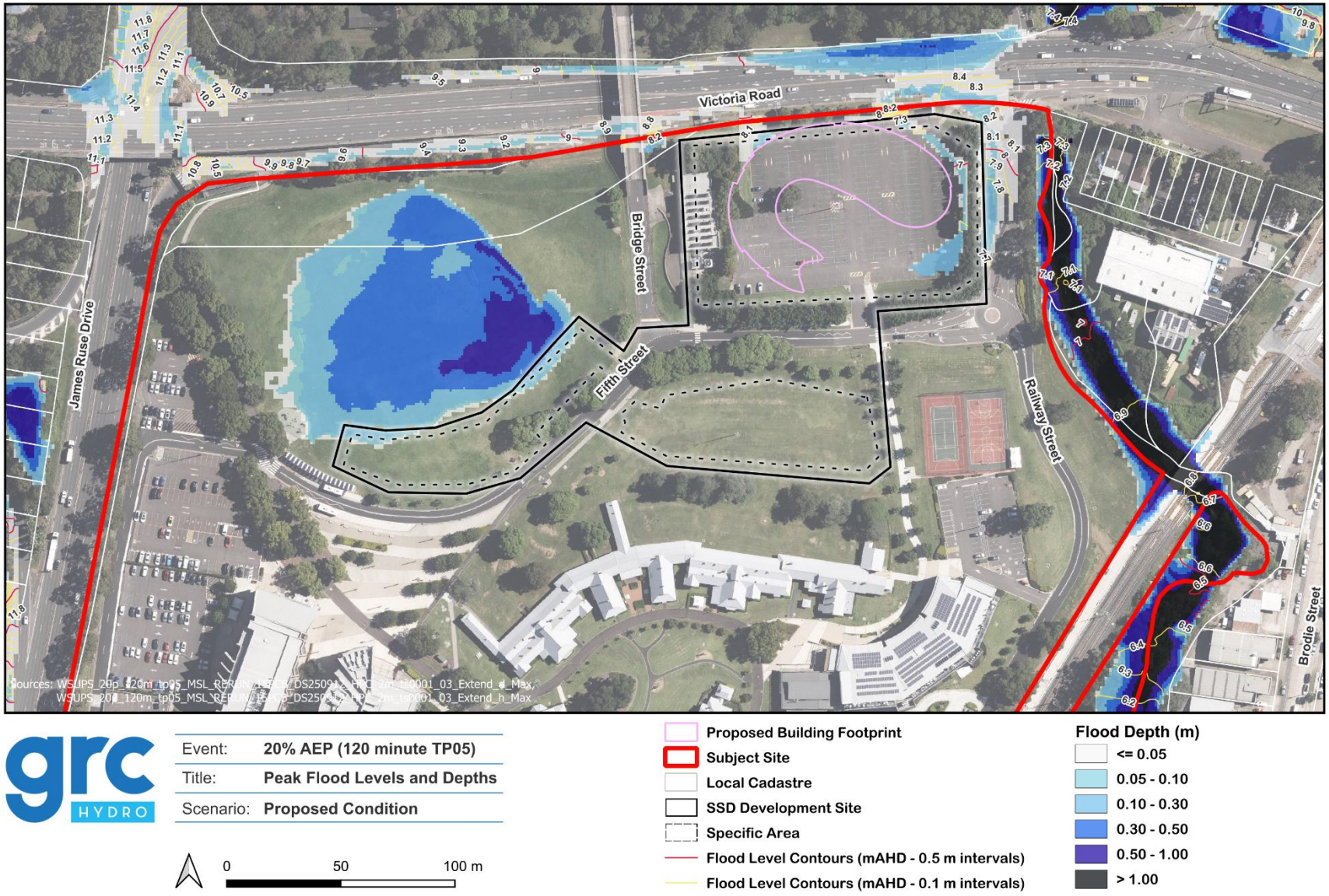


Figure 34: Flood Velocity and Hazard – 20% AEP – Developed Condition

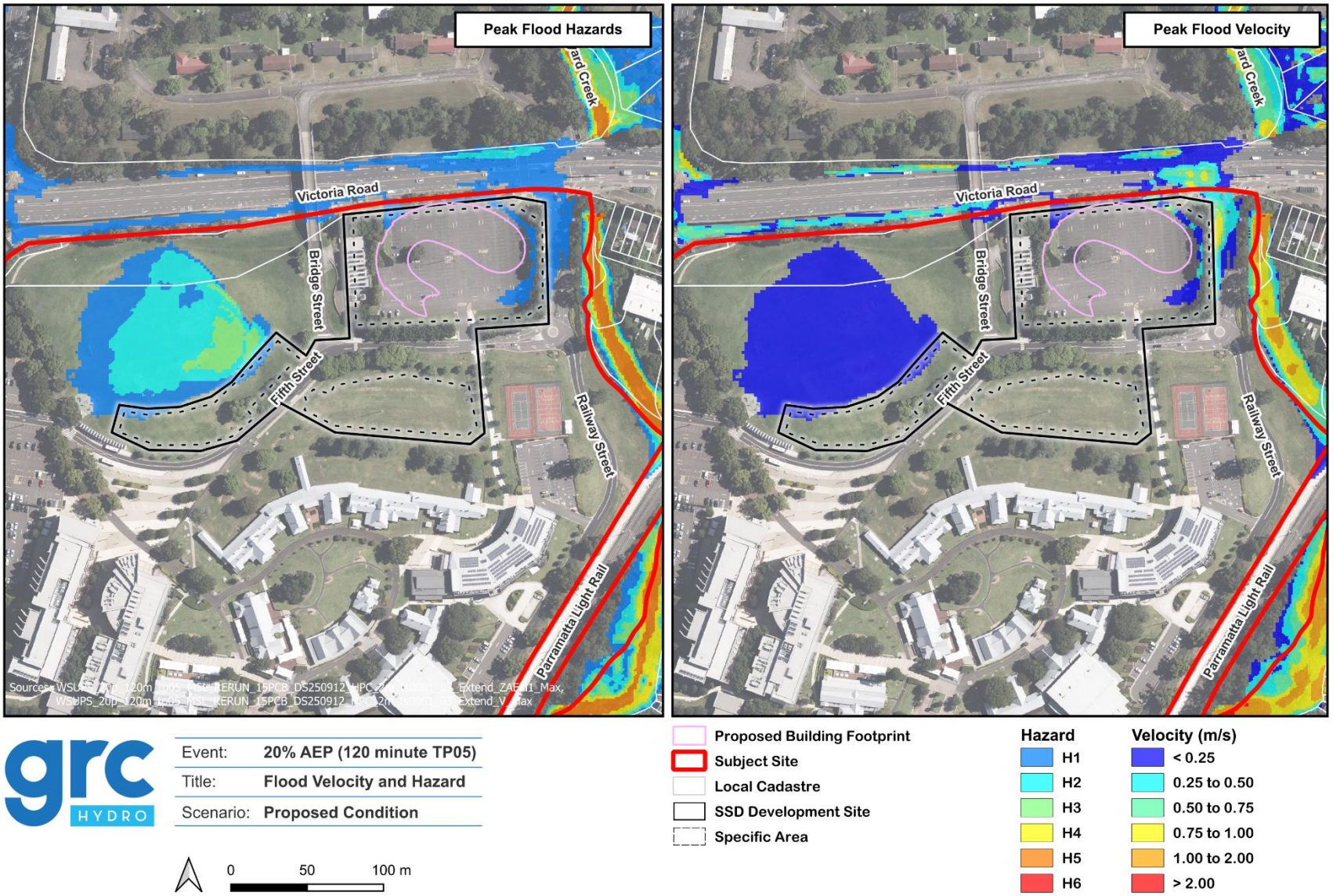


Figure 35: Flood Level Impact – 20% AEP – Developed Condition Minus Existing Condition

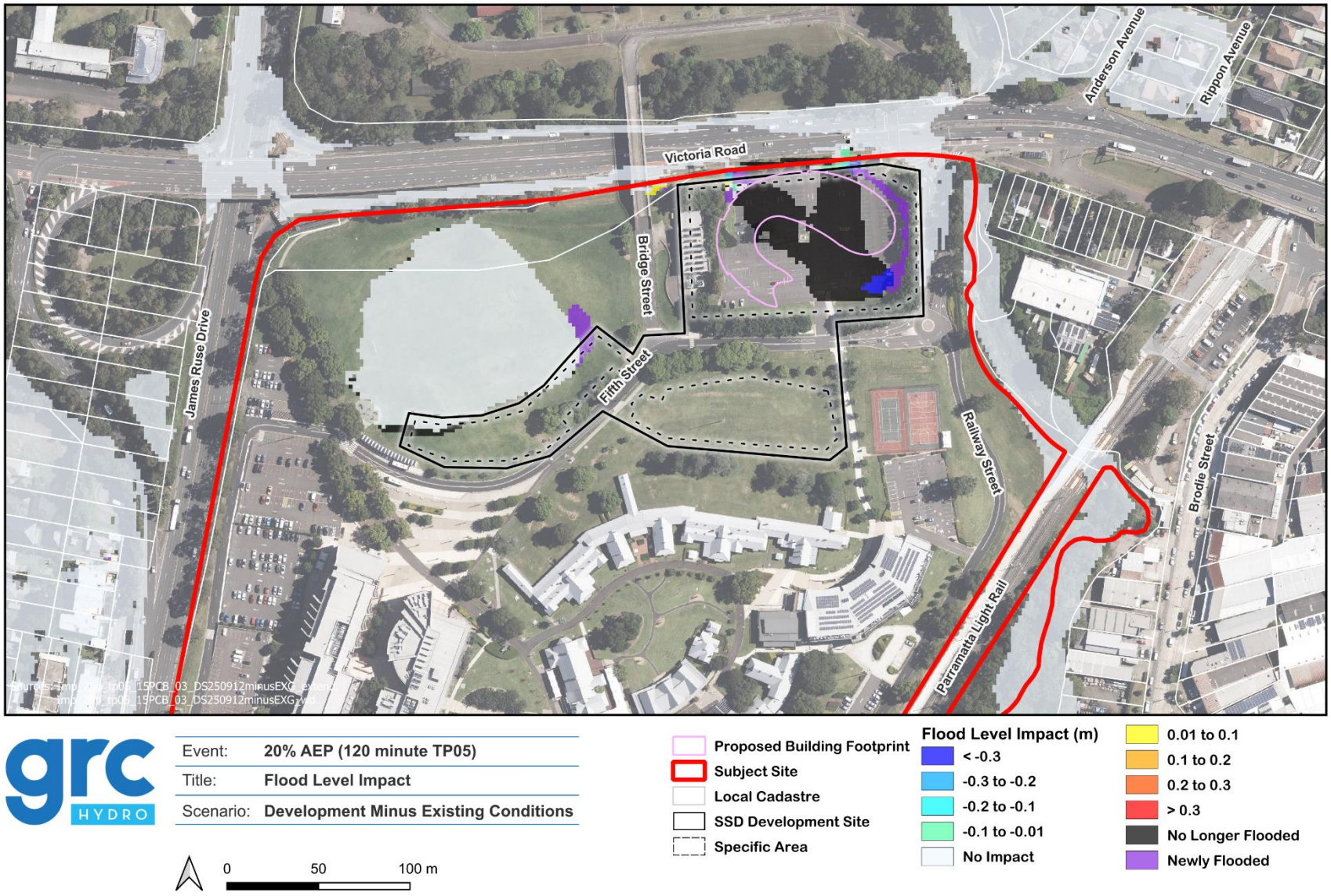


Figure 36: Peak Flood Levels and Depths – 5% AEP – Developed Condition

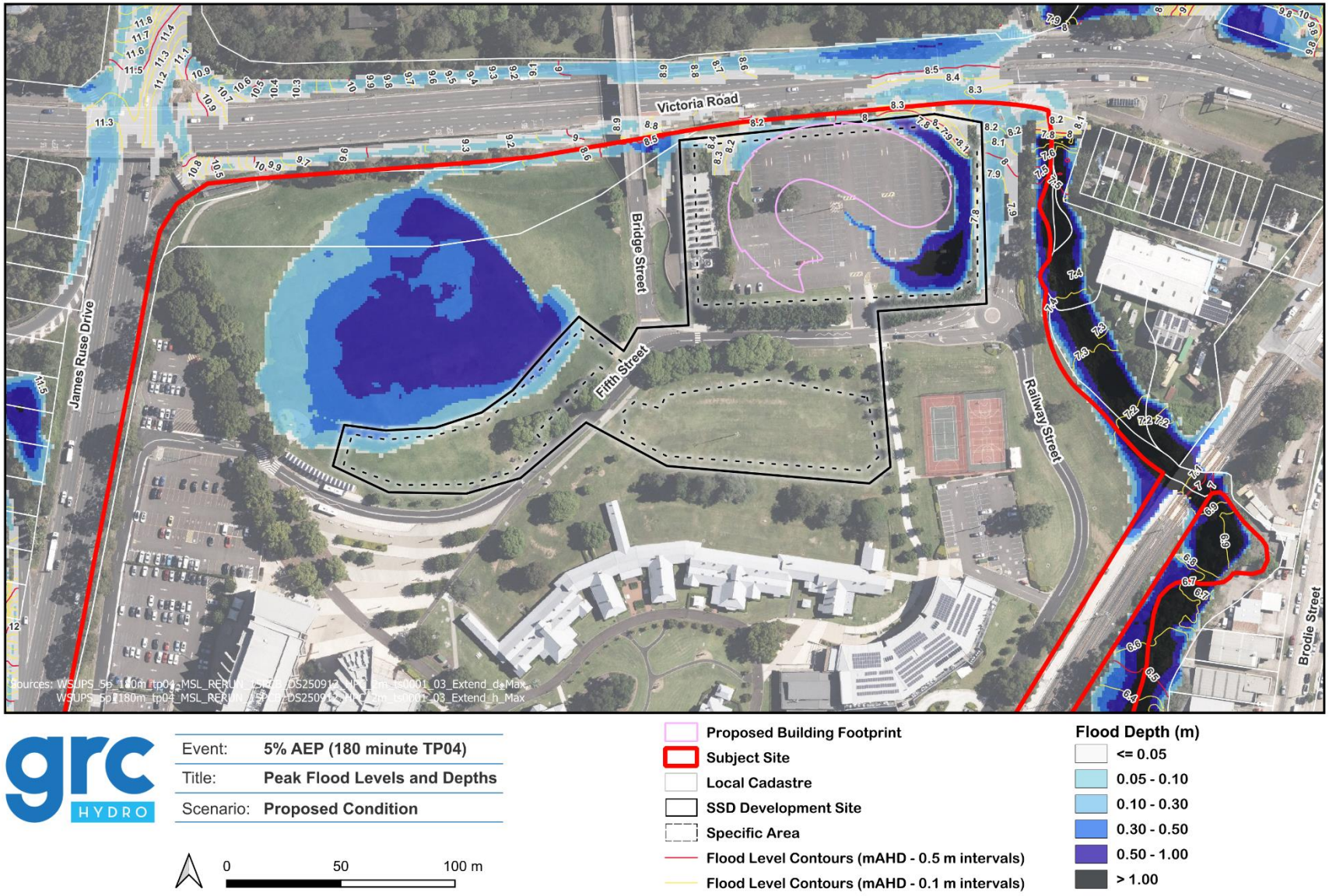


Figure 37: Flood Velocity and Hazard – 5% AEP – Developed Condition

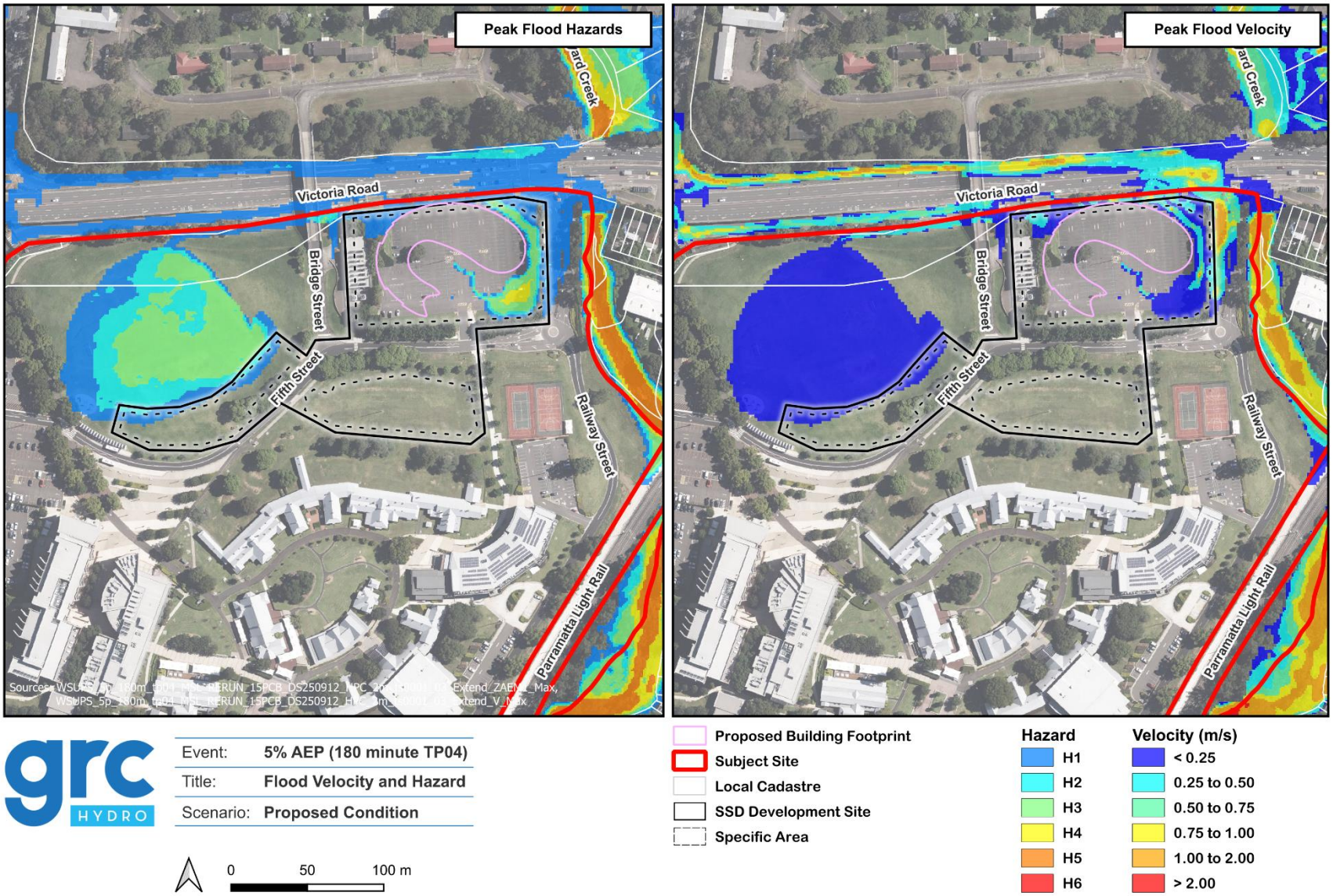


Figure 38: Flood Level Impact – 5% AEP – Developed Condition Minus Existing Condition

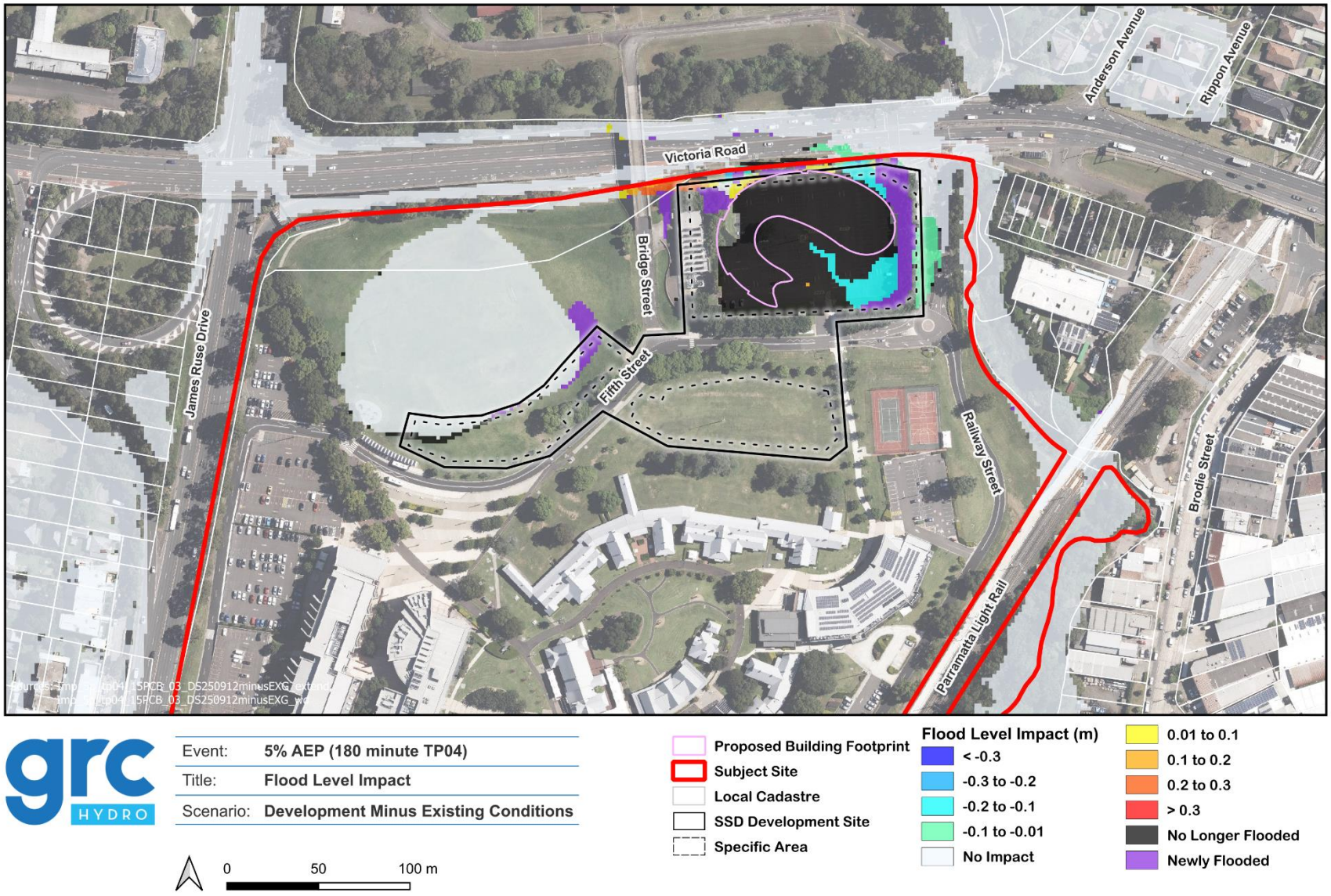


Figure 39: Peak Flood Levels and Depths – 1% AEP – Developed Condition

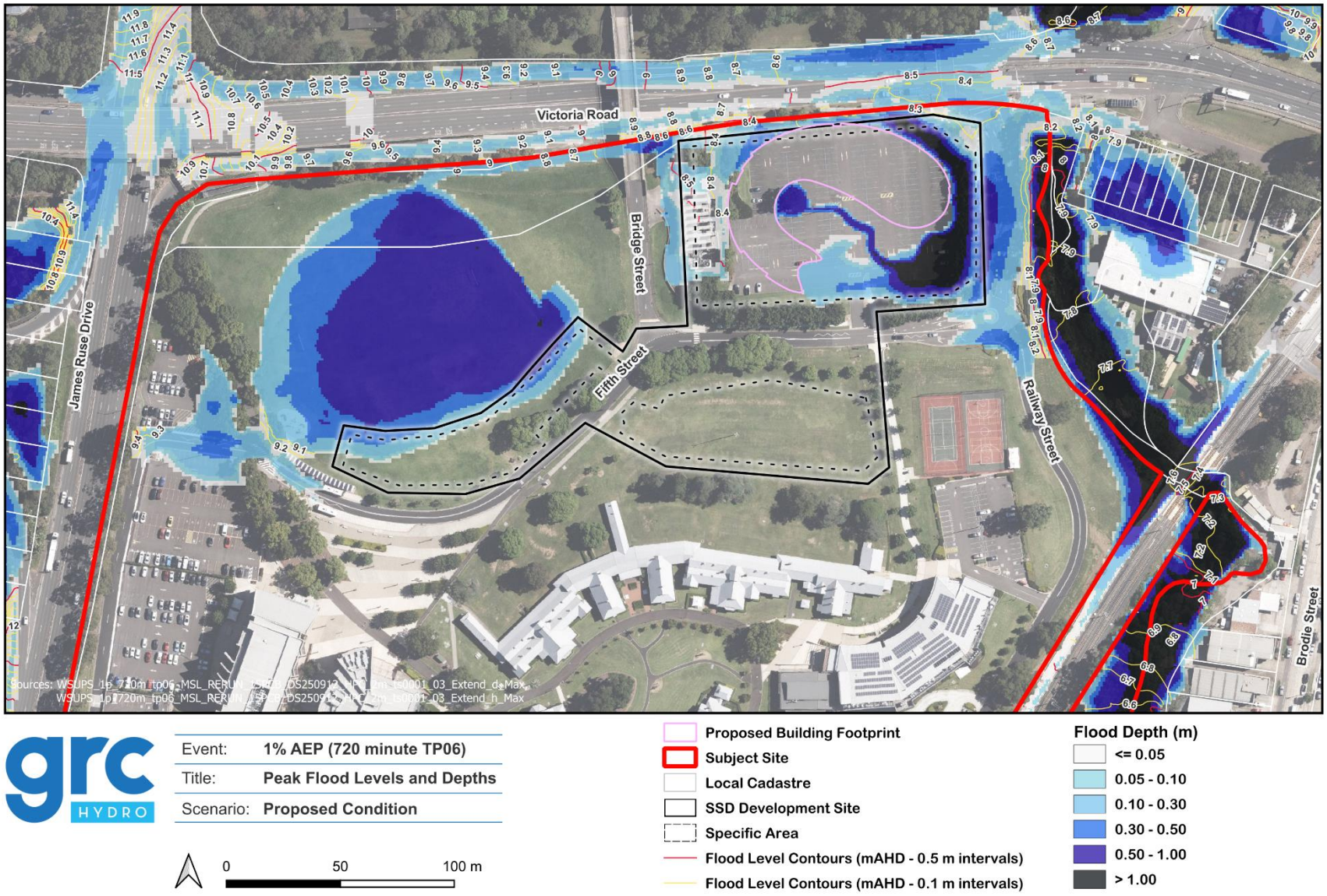


Figure 40: Flood Velocity and Hazard – 1% AEP – Developed Condition

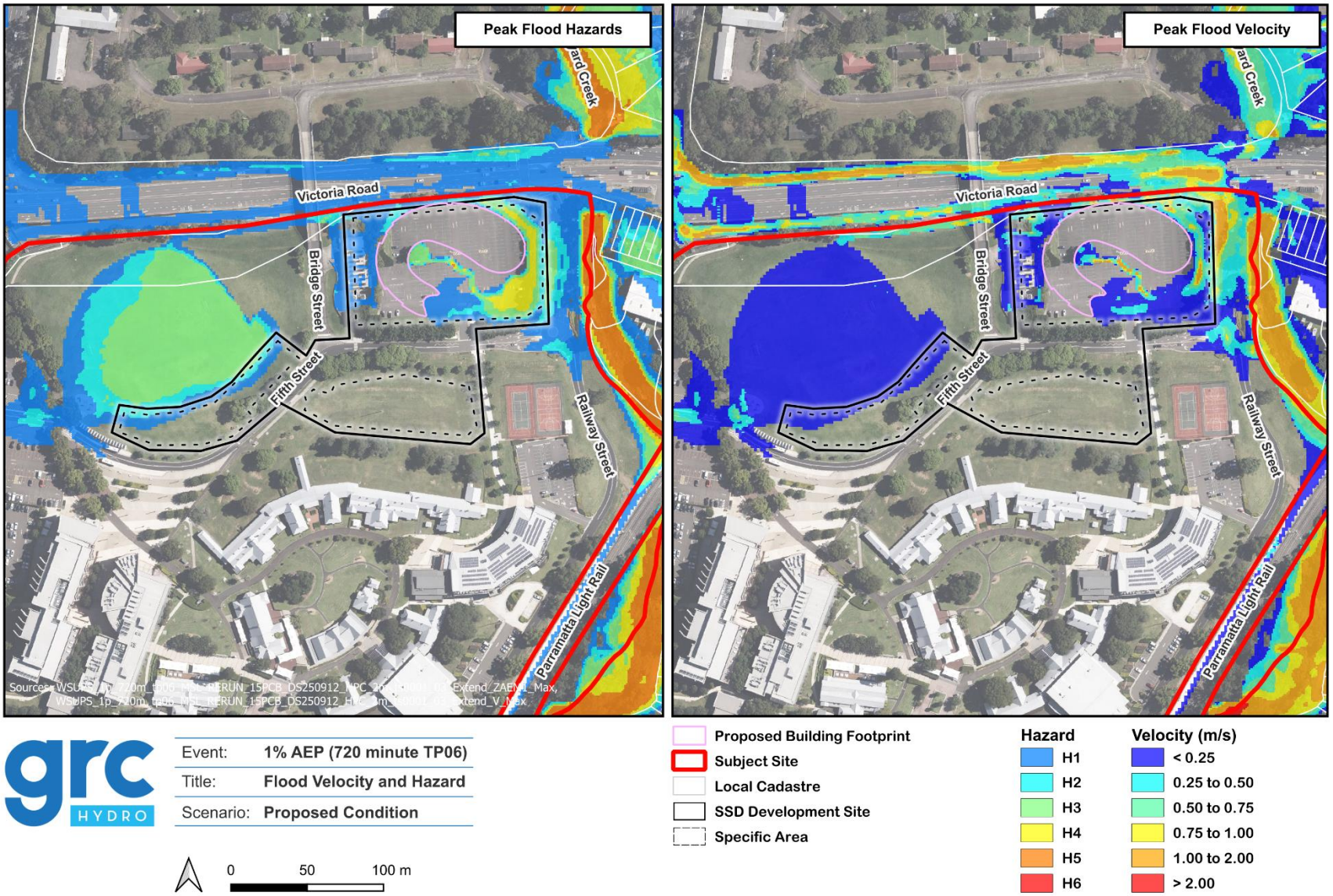


Figure 41: Flood Level Impact – 1% AEP – Developed Condition Minus Existing Condition

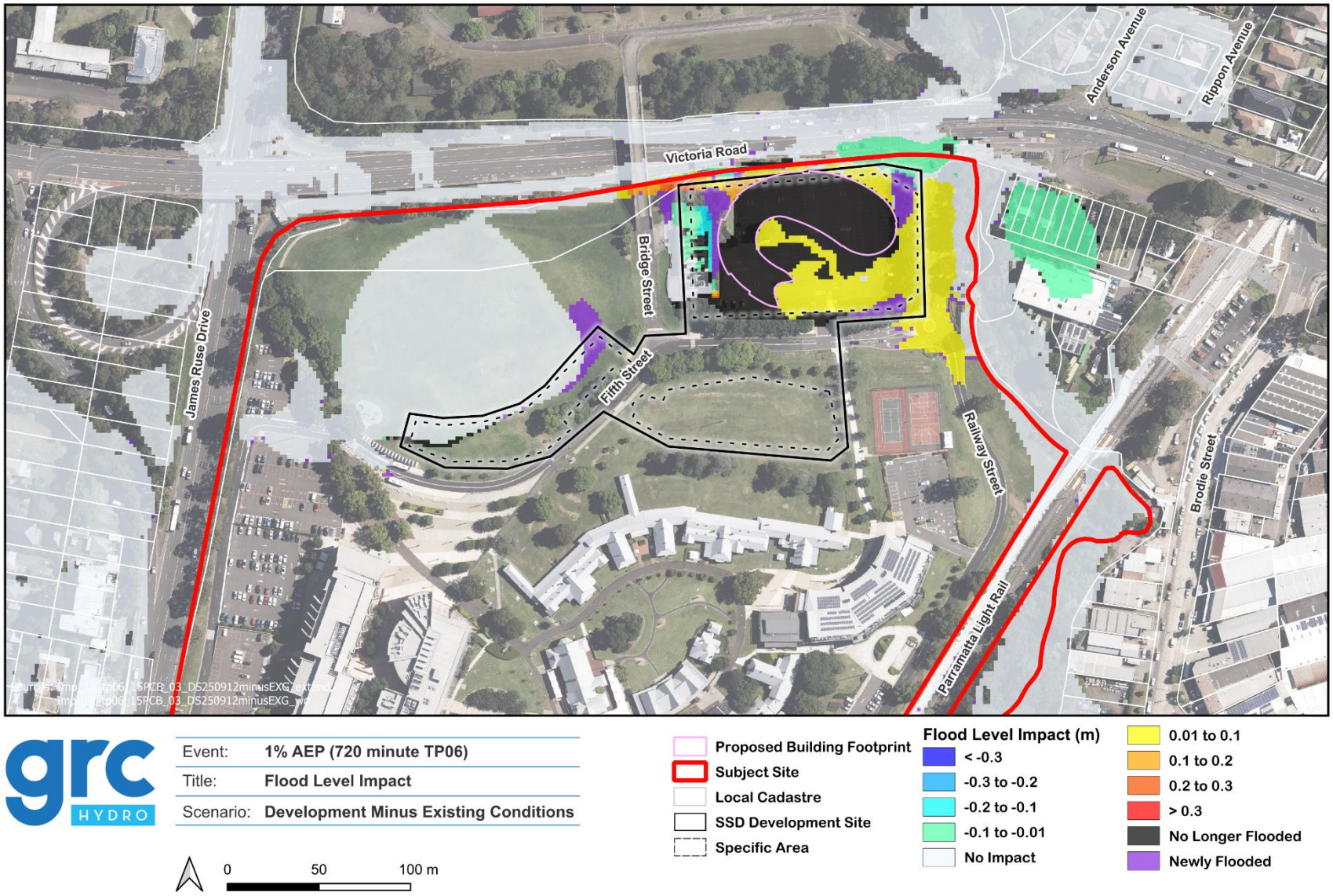


Figure 42: Flood Level Impact Sensitivity Analysis – 1% AEP – Developed Condition (50% Blockage minus No Blockage)

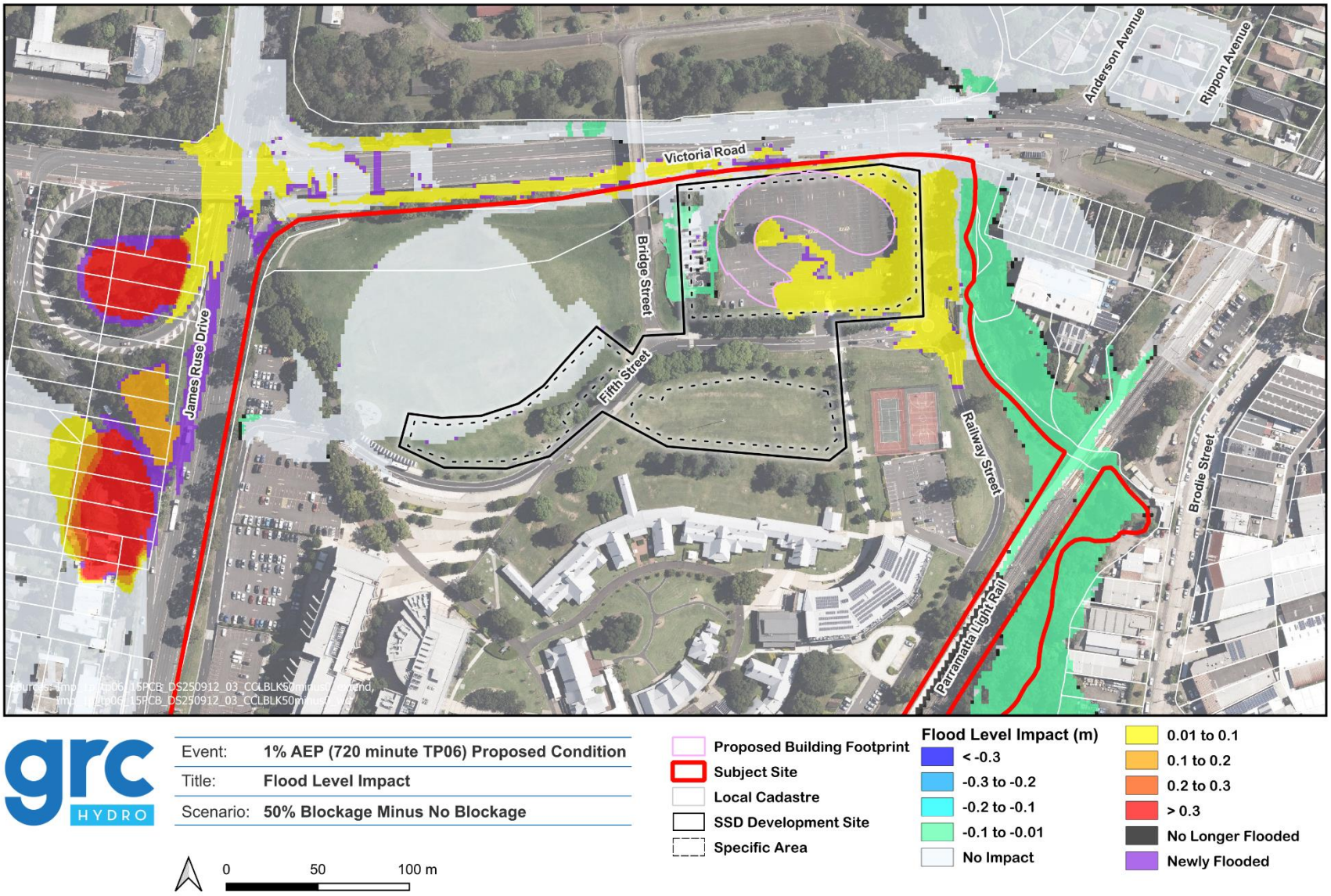


Figure 43: Flood Level Impact Sensitivity Analysis – 1% AEP – Developed Condition (100% Blockage minus No Blockage)

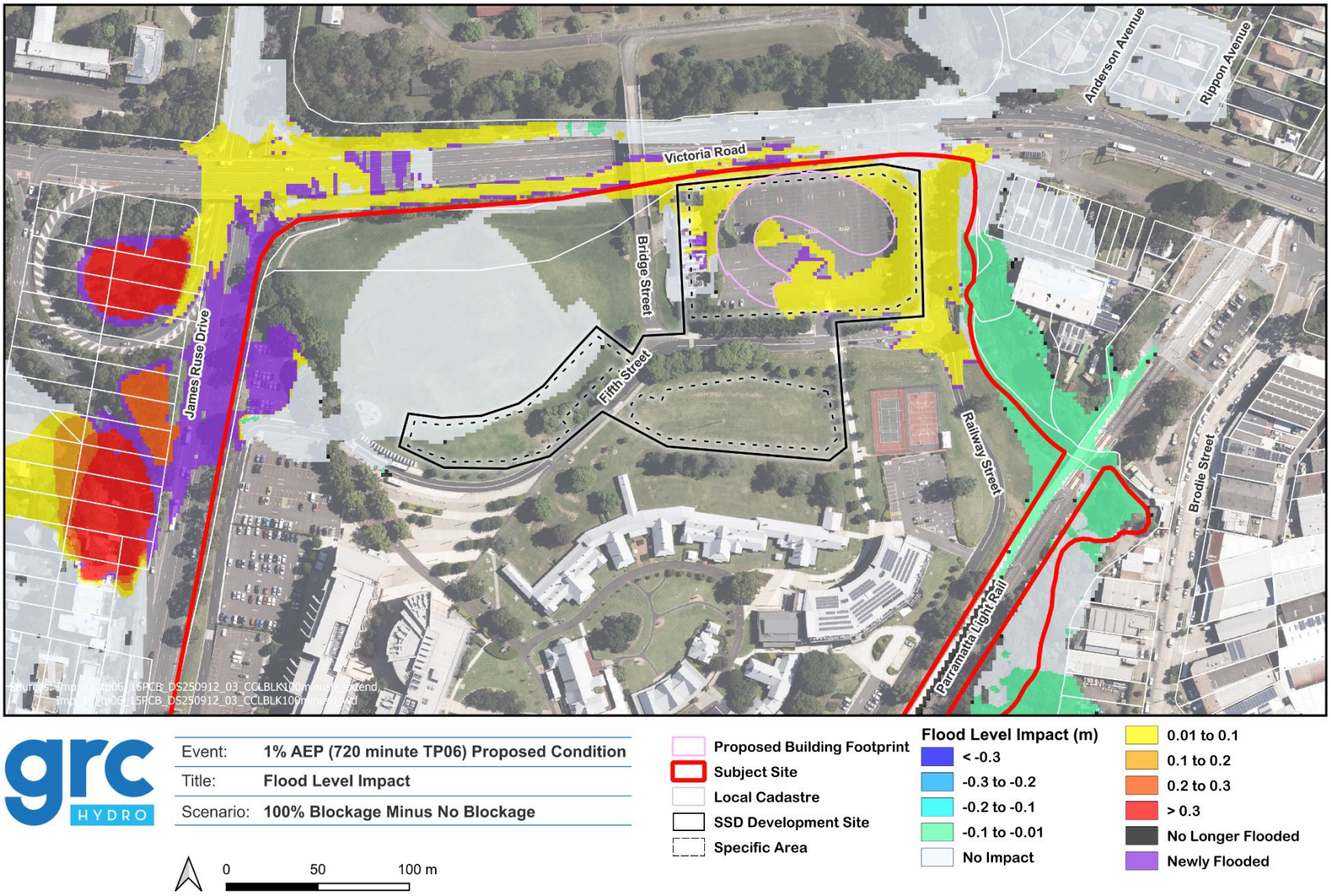


Figure 44: Flood Function – 1% AEP – Developed Condition

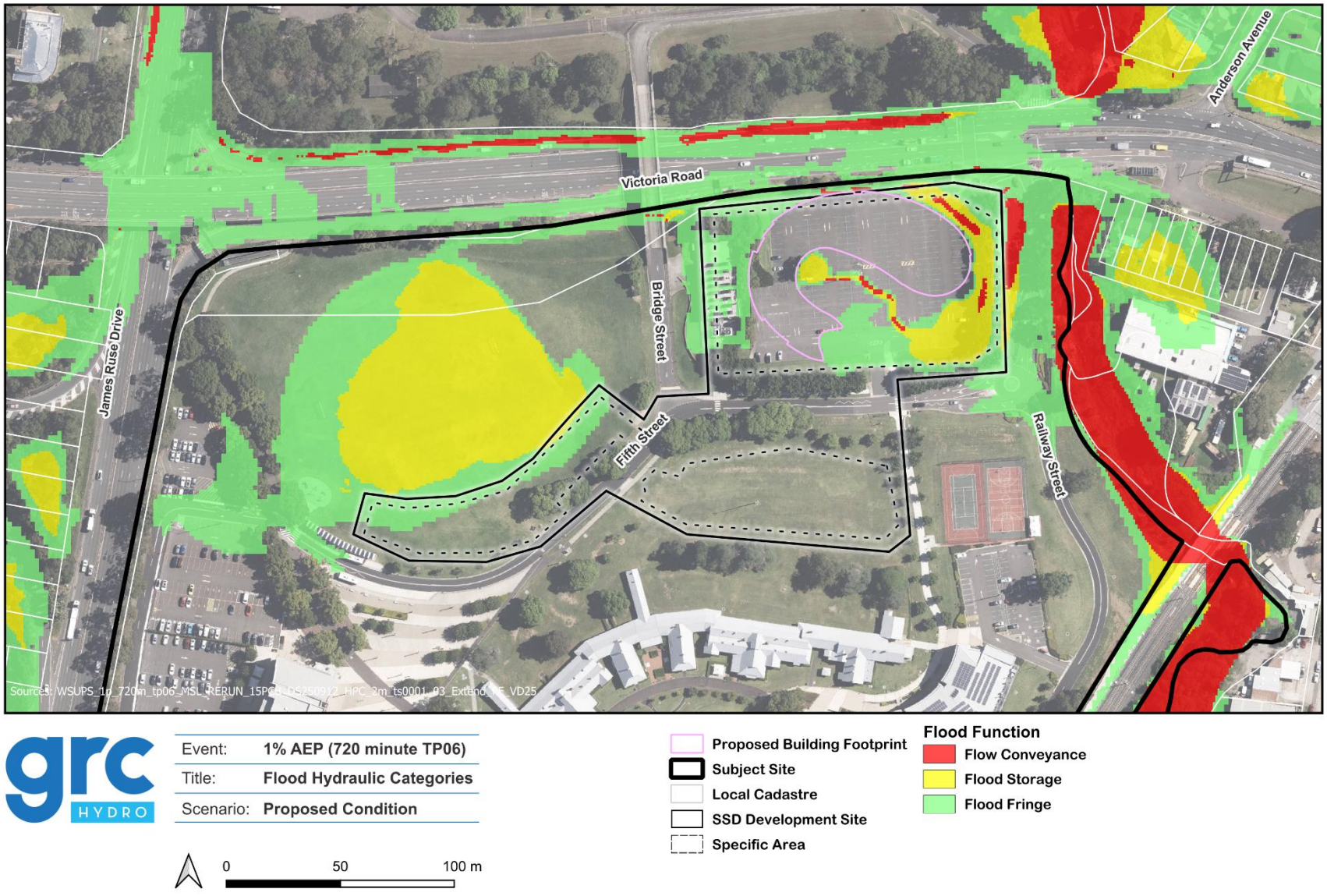


Figure 45: Peak Flood Levels and Depths – 1% AEP (present-day scaling rainfall loading)– Developed Condition

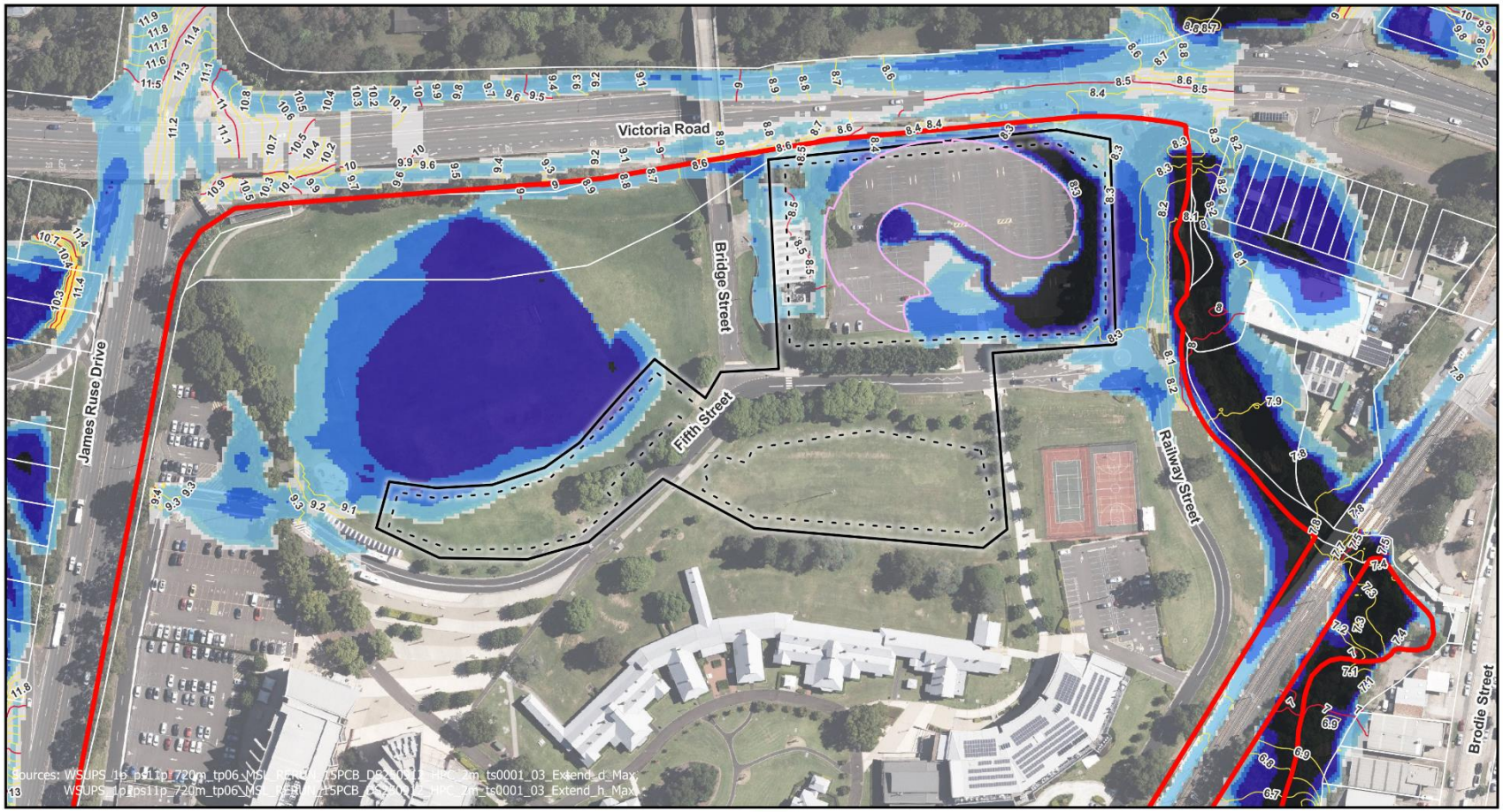


Figure 46: Flood Velocity and Hazard – 1% AEP (present-day scaling rainfall loading) – Developed Condition

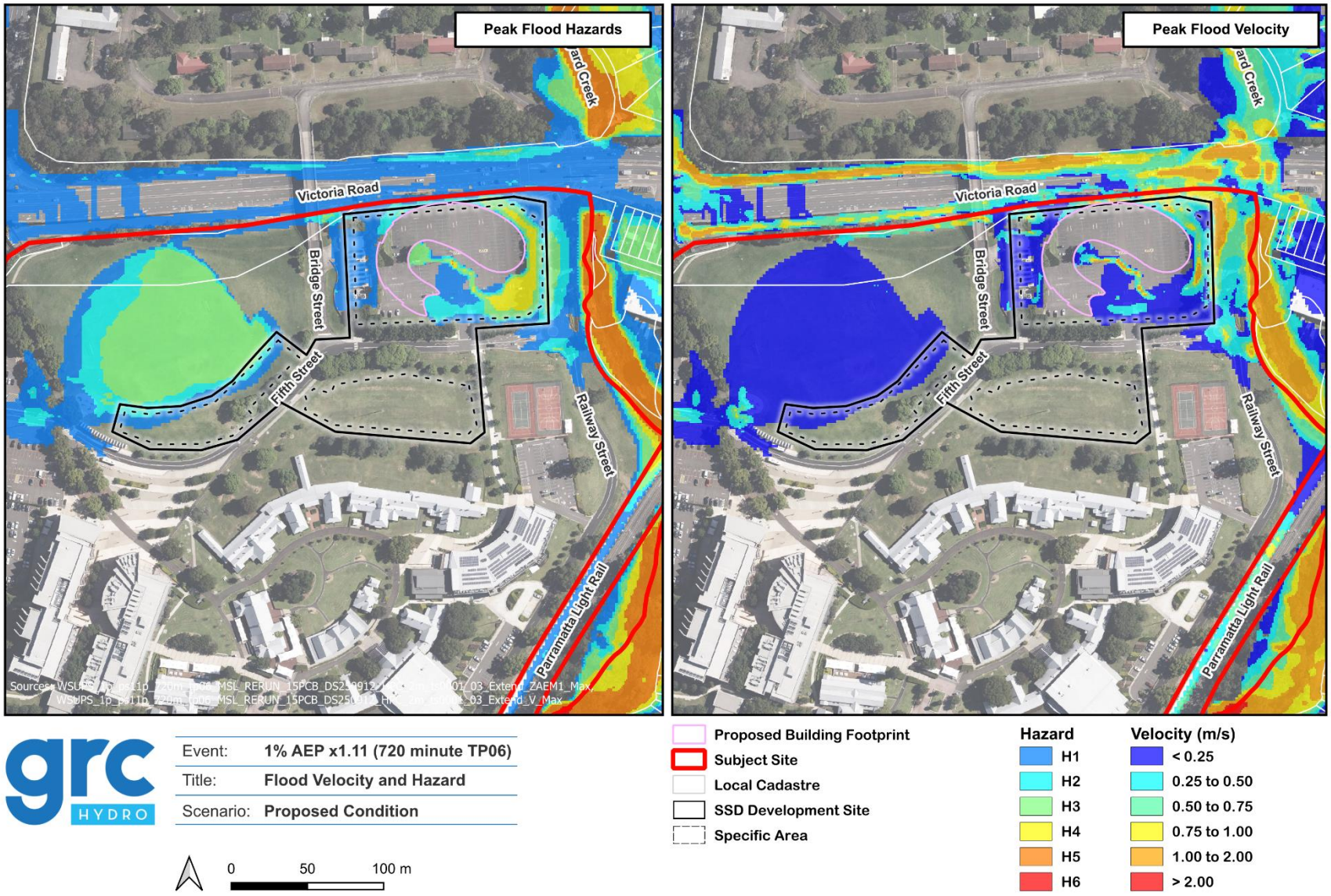


Figure 47: Flood Level Impact – 1% AEP (present-day scaling rainfall loading) – Developed Condition Minus Existing Condition

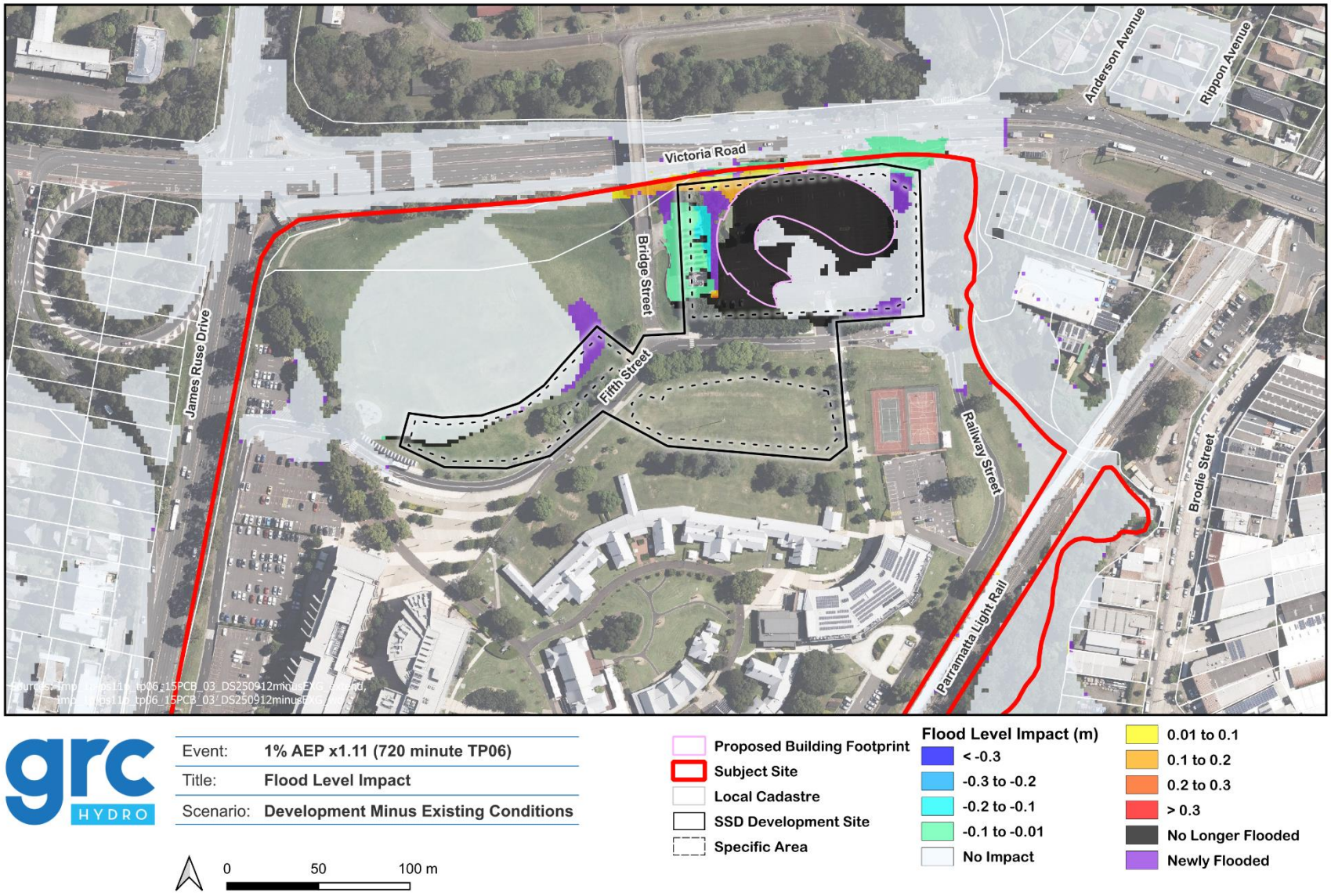


Figure 48: Peak Flood Levels and Depths – 1% AEP (with additional 19% rainfall loading)– Developed Condition

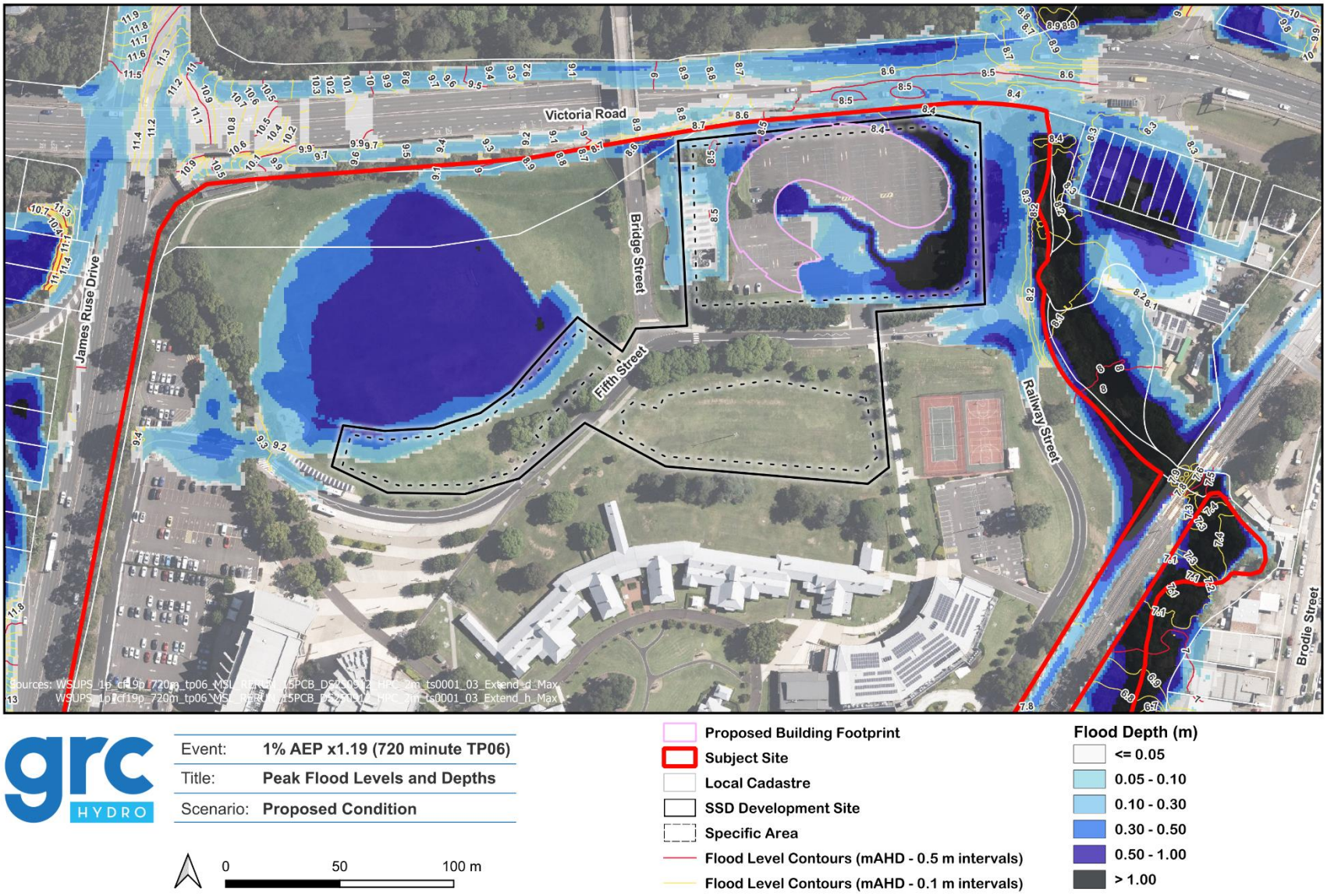


Figure 49: Flood Velocity and Hazard – 1% AEP (with additional 19% rainfall loading) – Developed Condition

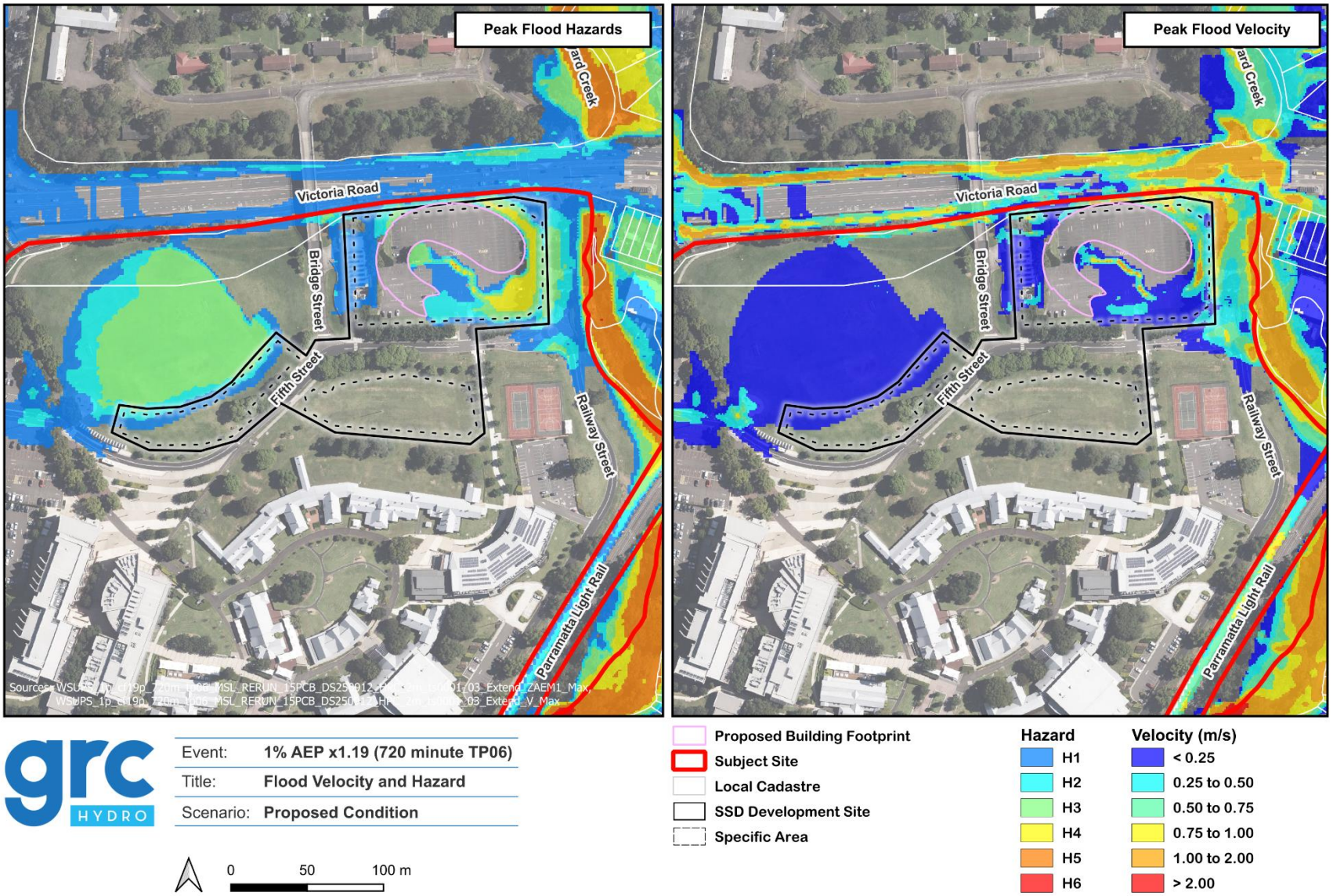


Figure 50: Flood Level Impact – 1% AEP ***(with additional 19% rainfall loading)*** *– Developed Condition Minus Existing Condition*

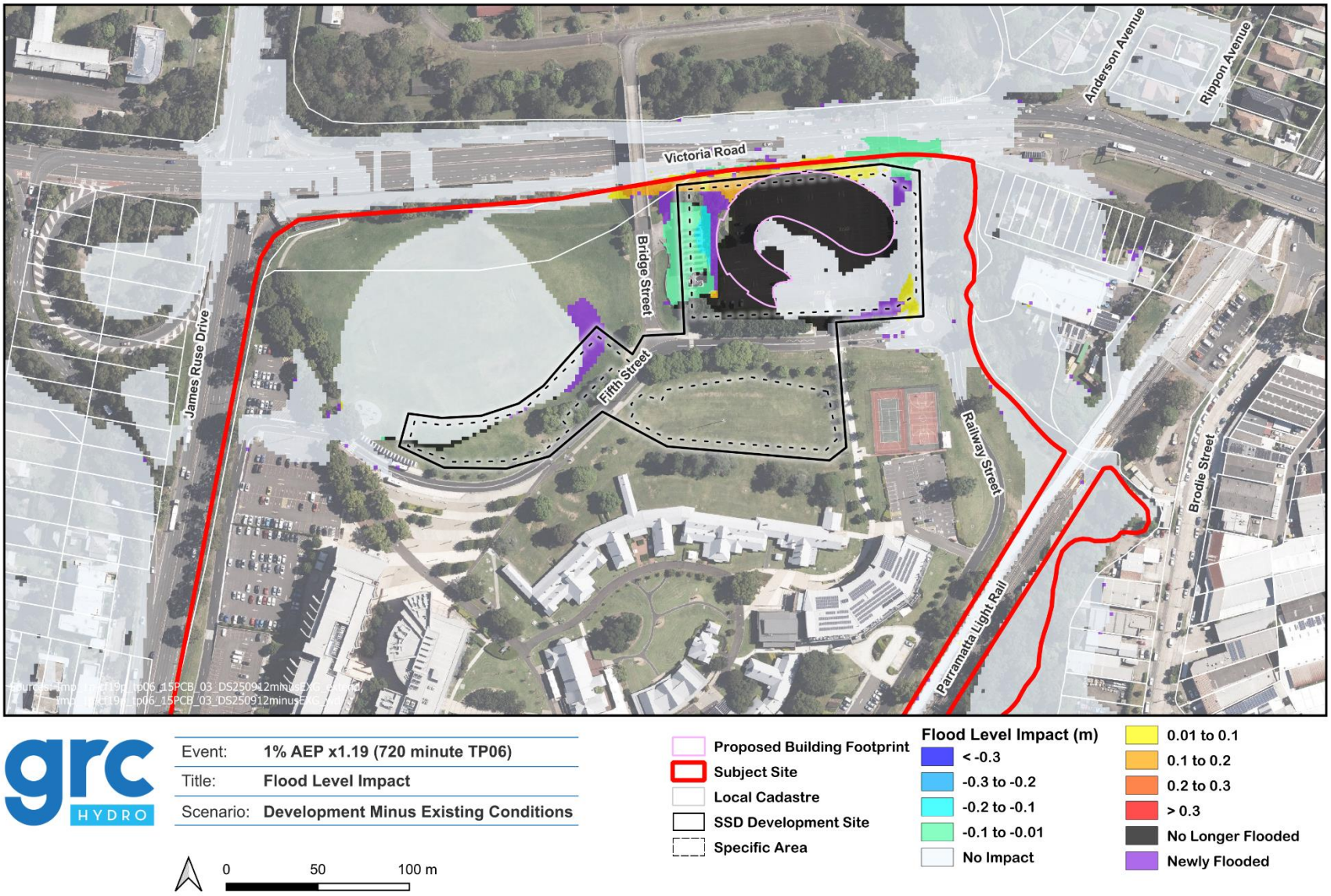
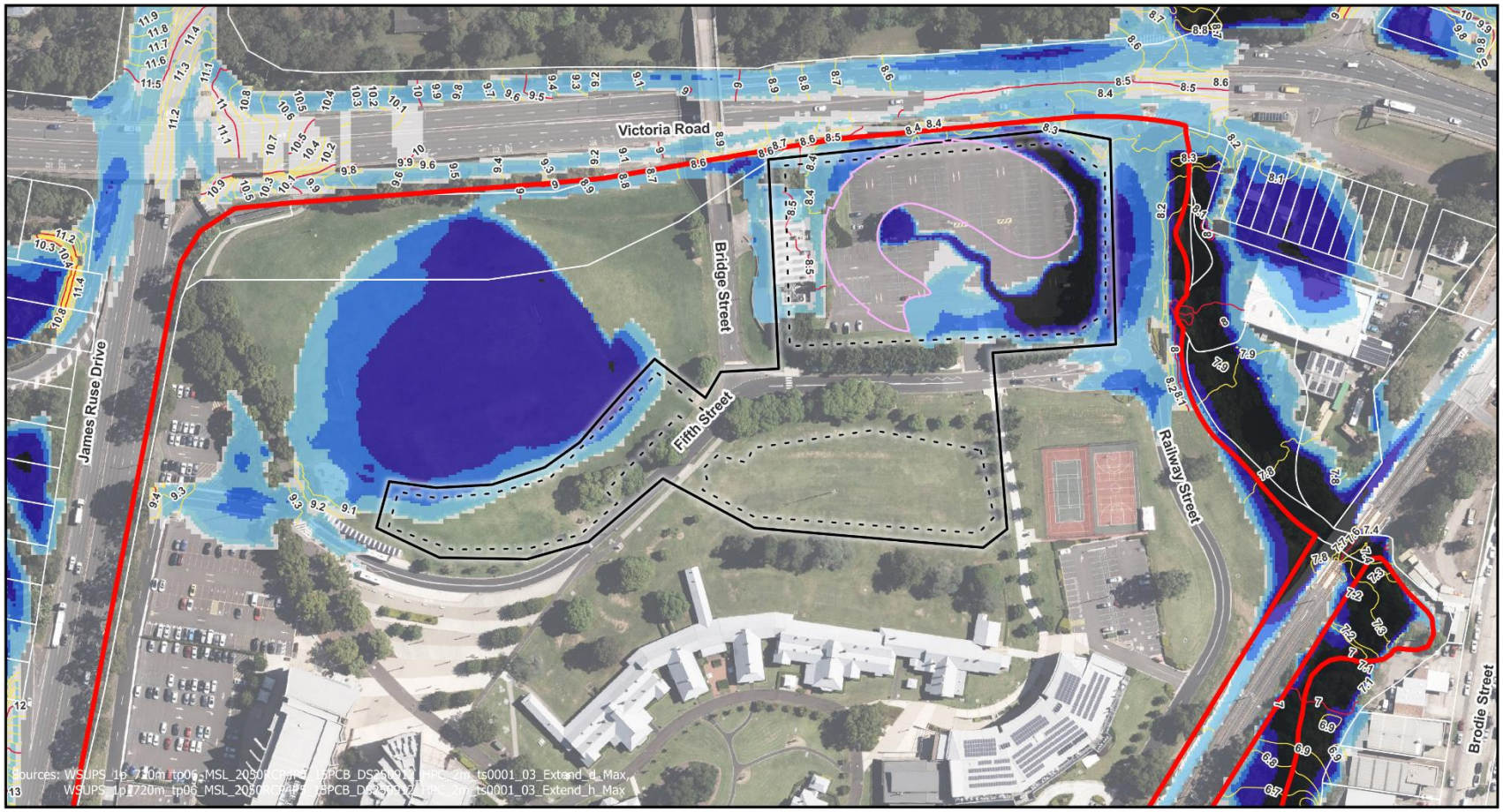


Figure 51: Peak Flood Levels and Depths – 1% AEP with Climate Change (RCP 4.5 2050) – Developed Condition



Event:	1% AEP (720 minute TP06) RCP4.5 2050
Title:	Peak Flood Levels and Depths
Scenario:	Proposed Condition

0 50 100 m

- Proposed Building Footprint
- Subject Site
- Local Cadastre
- SSD Development Site
- Specific Area
- Flood Level Contours (mAHD - 0.5 m intervals)
- Flood Level Contours (mAHD - 0.1 m intervals)

Flood Depth (m)

- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Figure 52: Flood Velocity and Hazard – 1% AEP with Climate Change (RCP 4.5 2050) – Developed Condition

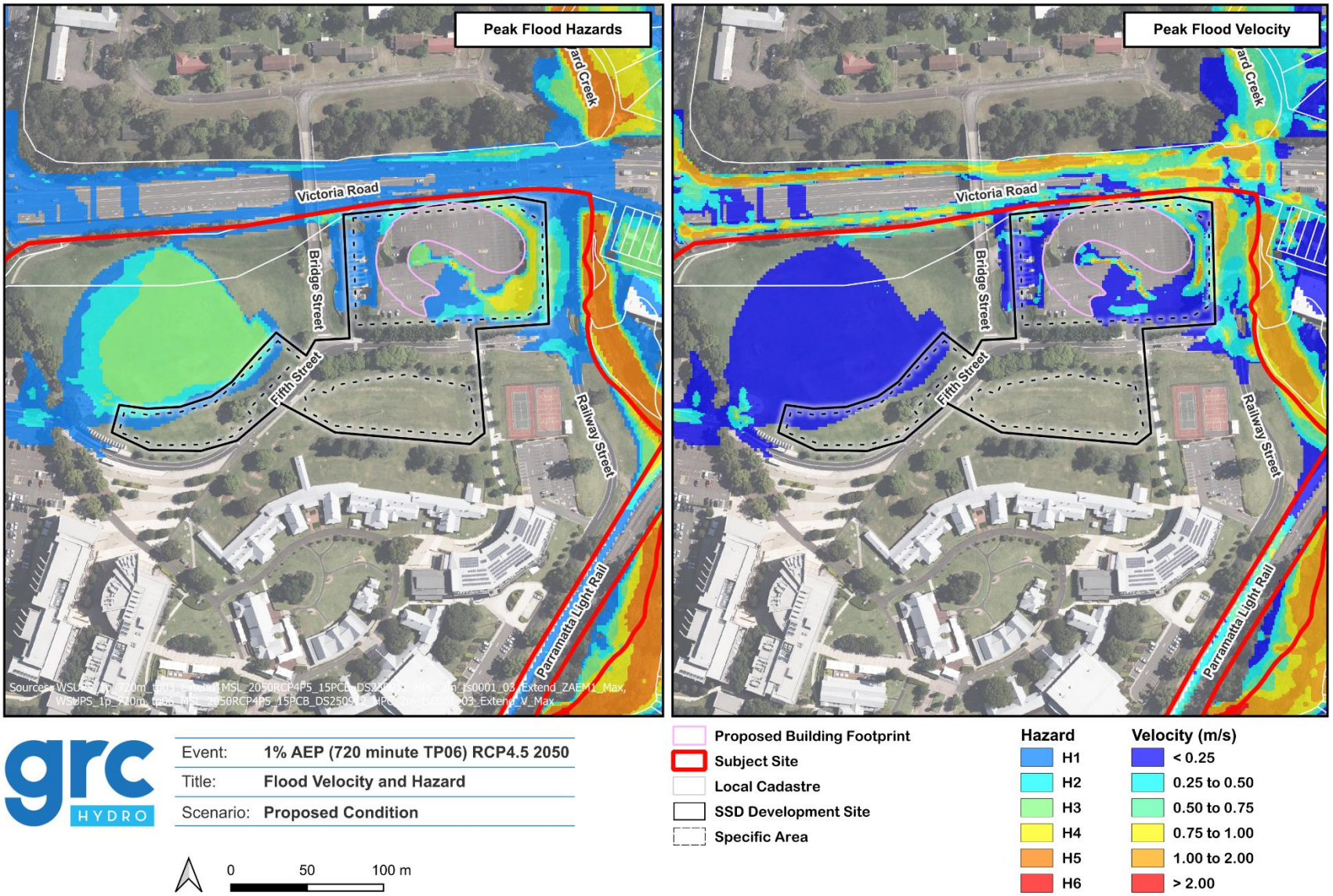


Figure 53: Flood Level Impact – 1% AEP with Climate Change (RCP 4.5 2050) – Developed Condition Minus Existing Condition

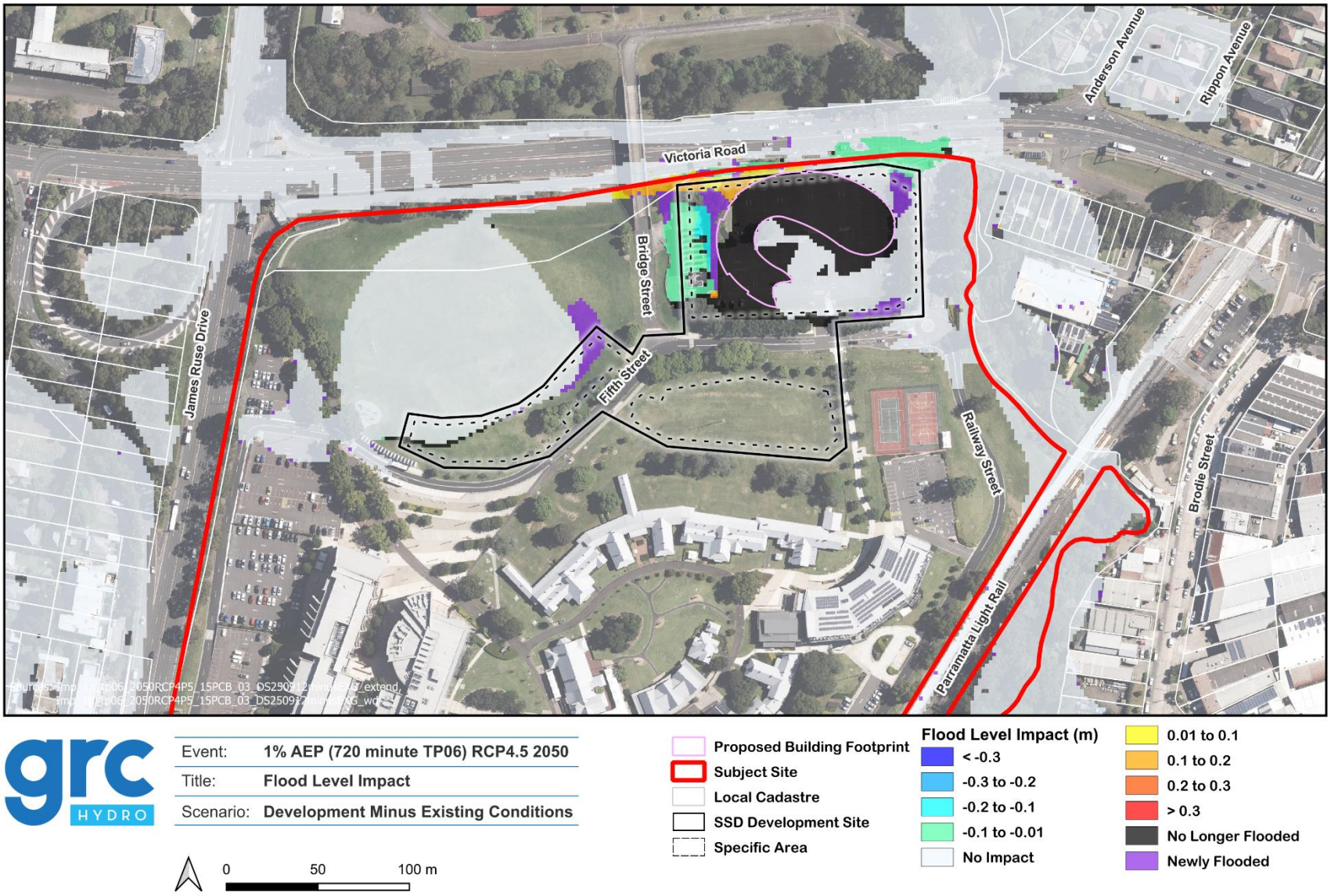


Figure 54: Peak Flood Levels and Depths – 1% AEP with Climate Change (RCP 4.5 2090) – Developed Condition

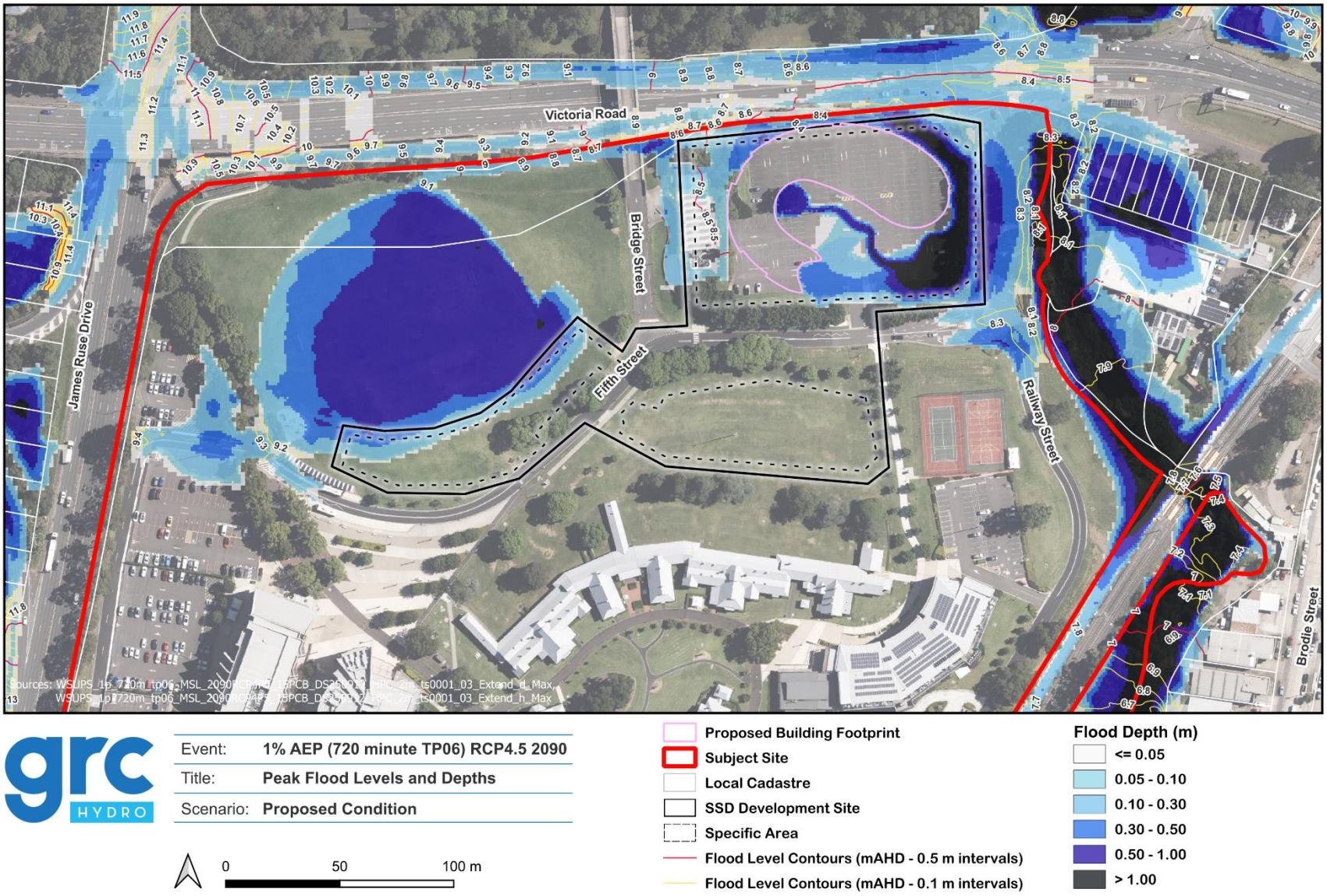


Figure 55: Flood Velocity and Hazard – 1% AEP with Climate Change (RCP 4.5 2090) – Developed Condition

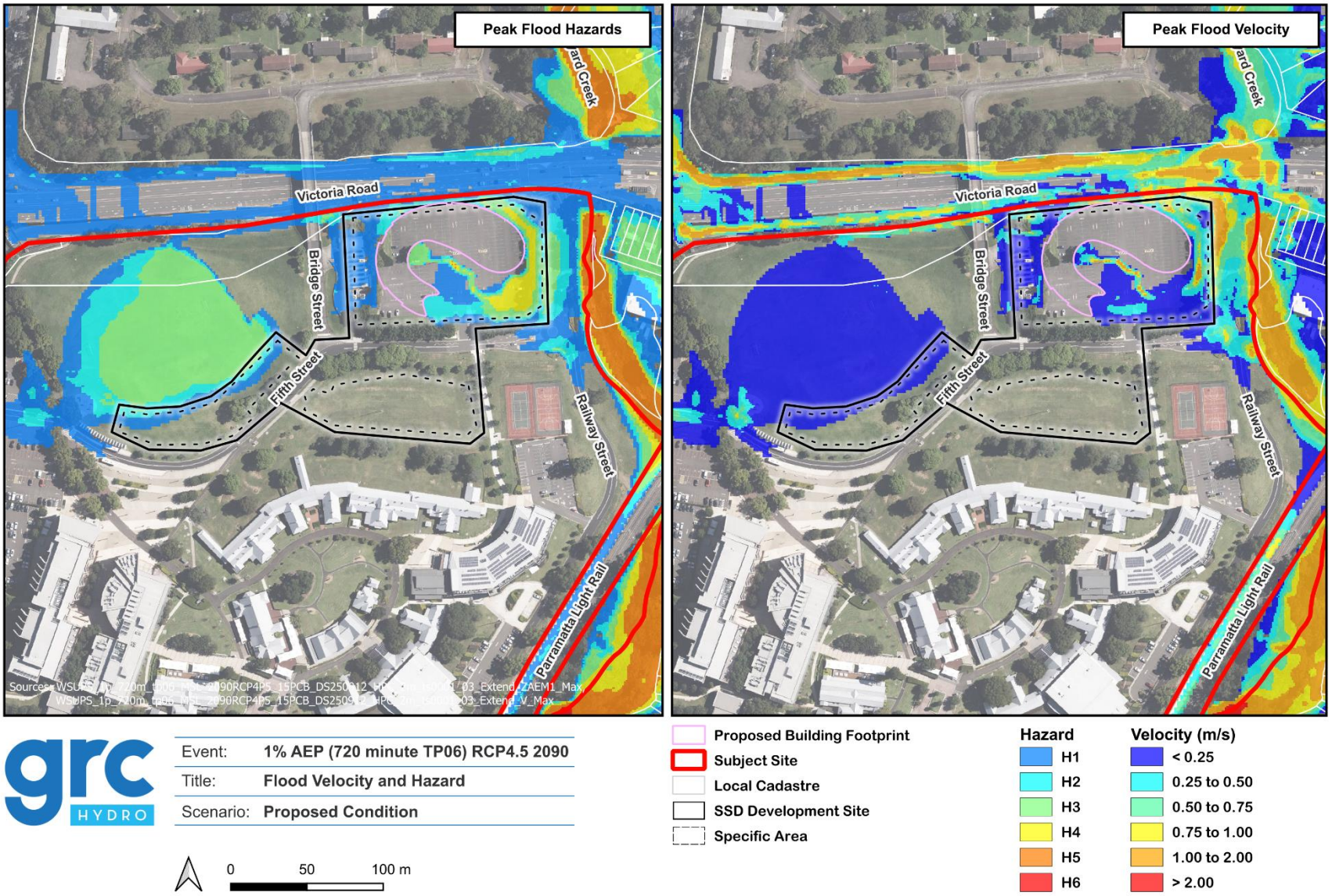


Figure 56: Flood Level Impact – 1% AEP with Climate Change (RCP 4.5 2090) – Developed Condition Minus Existing Condition

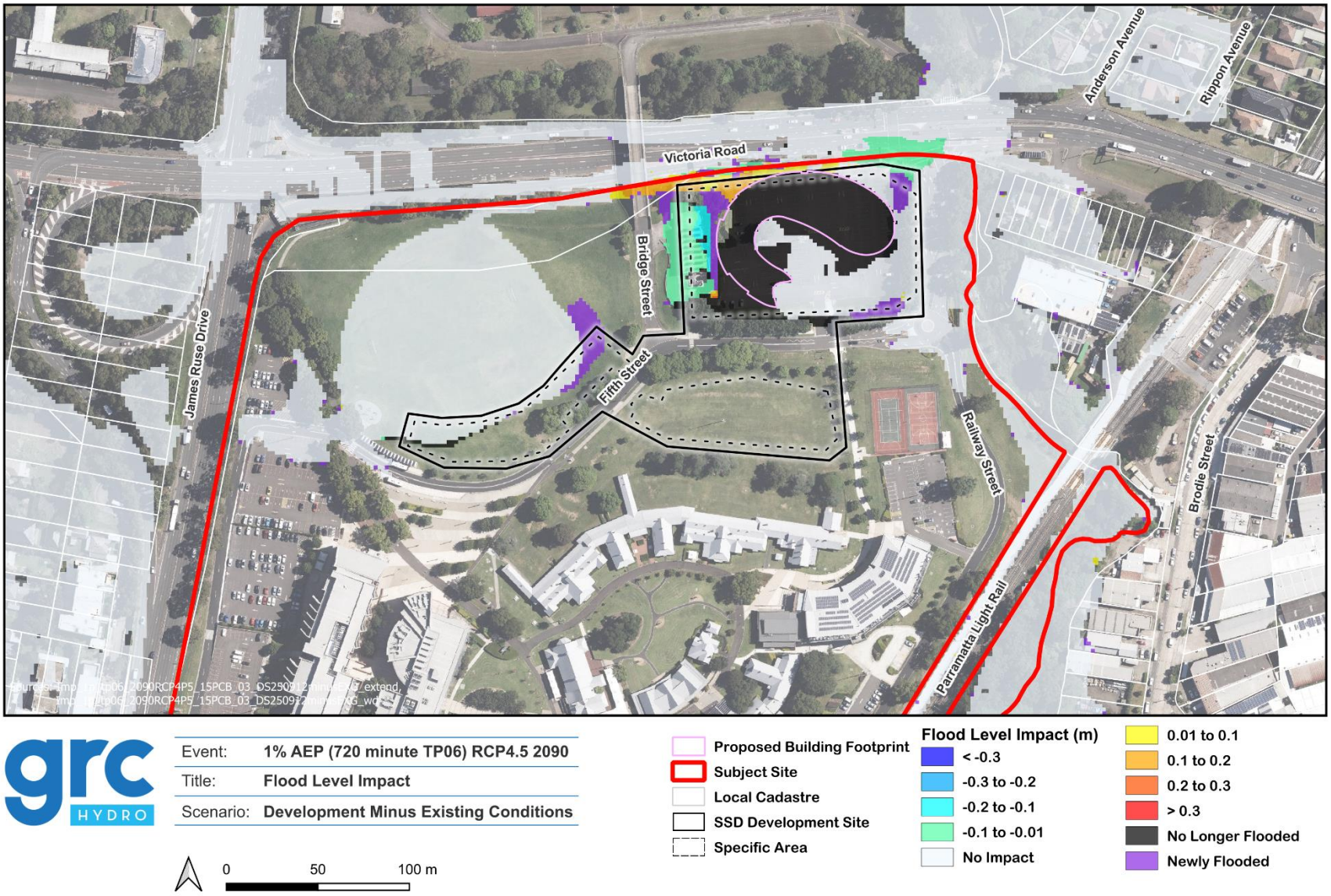


Figure 57: Peak Flood Levels and Depths – 0.2% AEP – Developed Condition

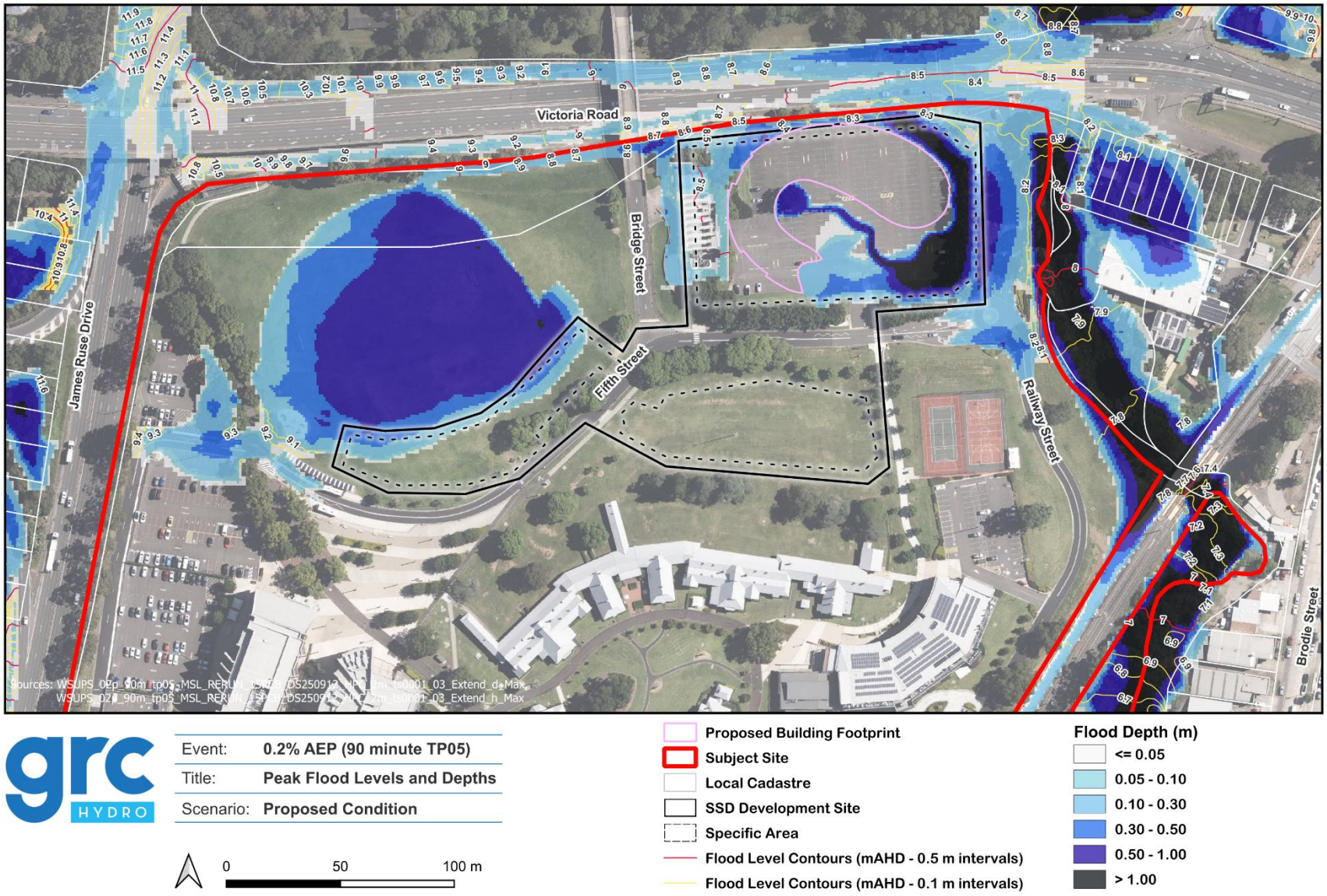


Figure 58: Flood Velocity and Hazard – 0.2% AEP – Developed Condition

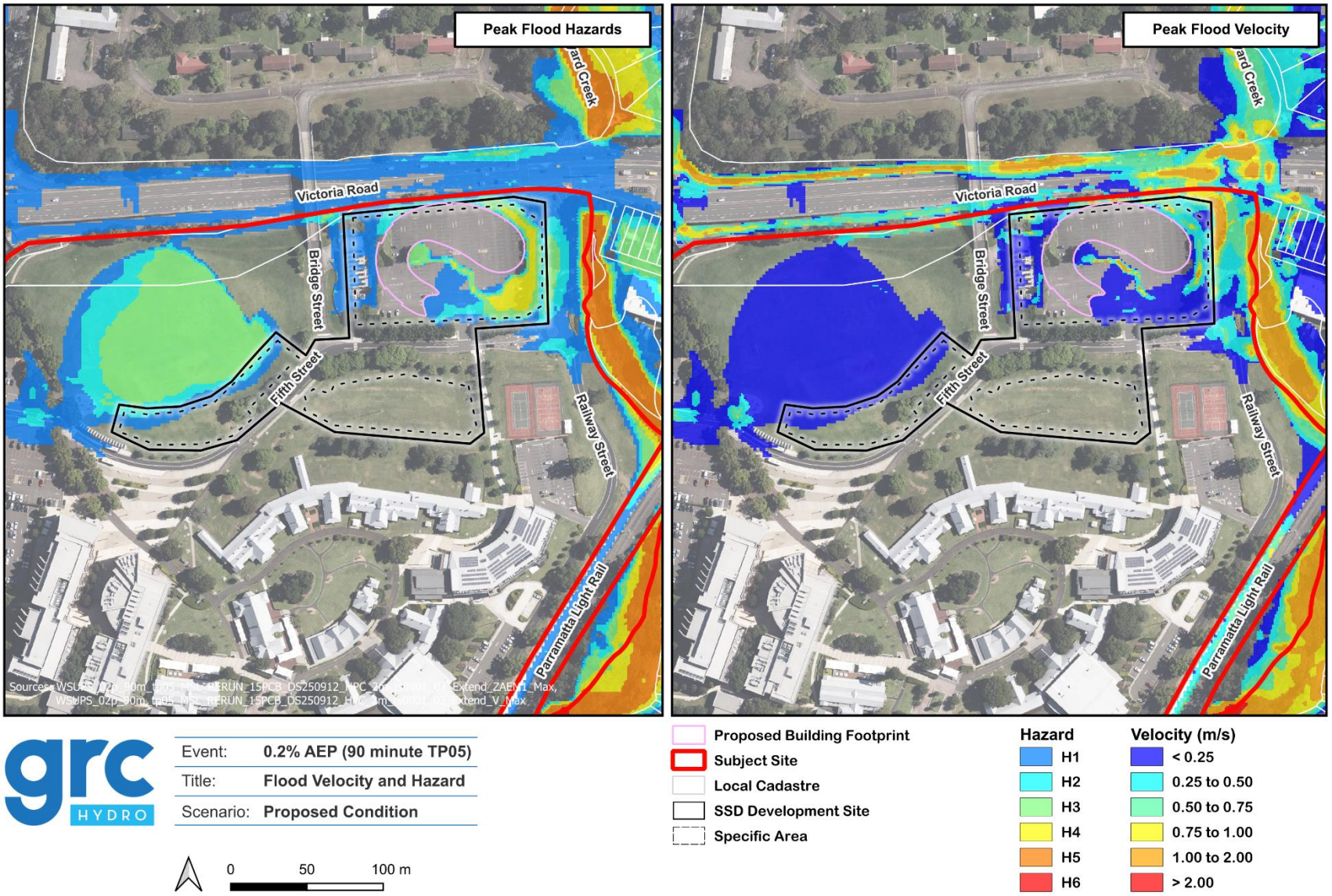


Figure 59: Flood Level Impact – 0.2% AEP – Developed Condition Minus Existing Condition

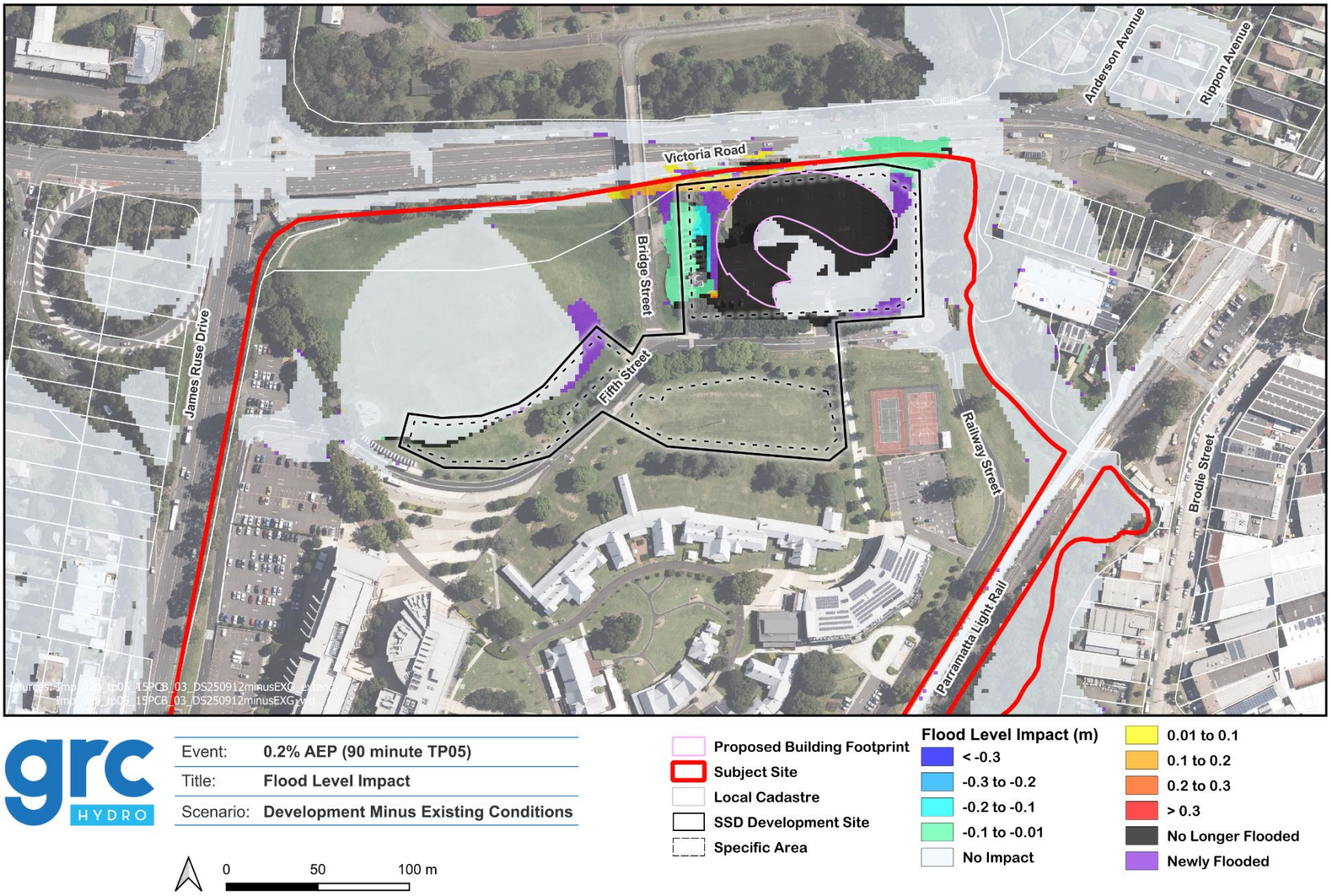
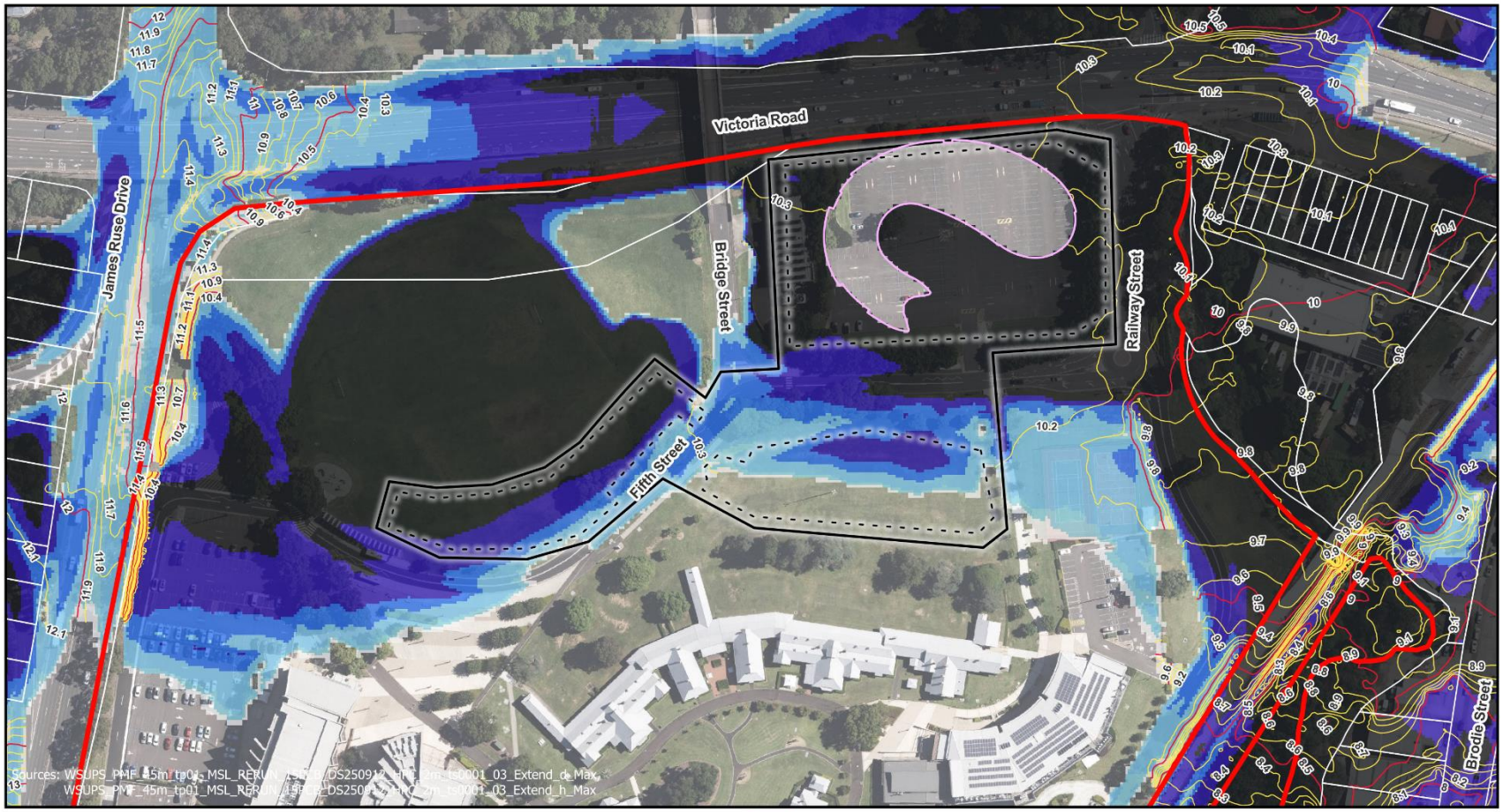


Figure 60: Peak Flood Levels and Depths – PMF – Developed Condition



Event:	PMF (45 minute TP01)
Title:	Peak Flood Levels and Depths
Scenario:	Proposed Condition

0 50 100 m

Proposed Building Footprint
Subject Site
Local Cadastre
SSD Development Site
Specific Area
Flood Level Contours (mAHD - 0.5 m intervals)
Flood Level Contours (mAHD - 0.1 m intervals)

Flood Depth (m)
- <= 0.05
- 0.05 - 0.10
- 0.10 - 0.30
- 0.30 - 0.50
- 0.50 - 1.00
- > 1.00

Figure 61: Flood Velocity and Hazard – PMF – Developed Condition

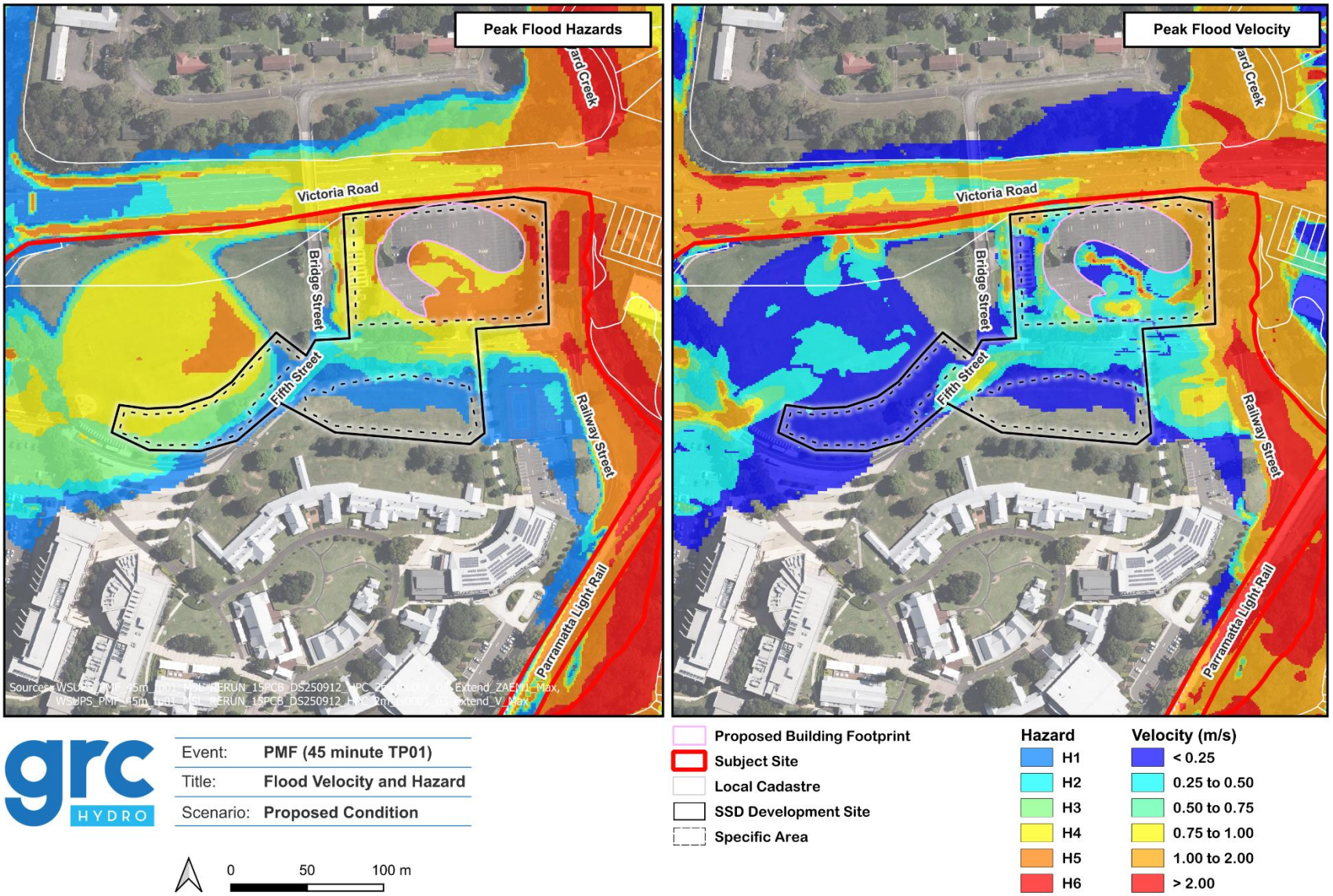
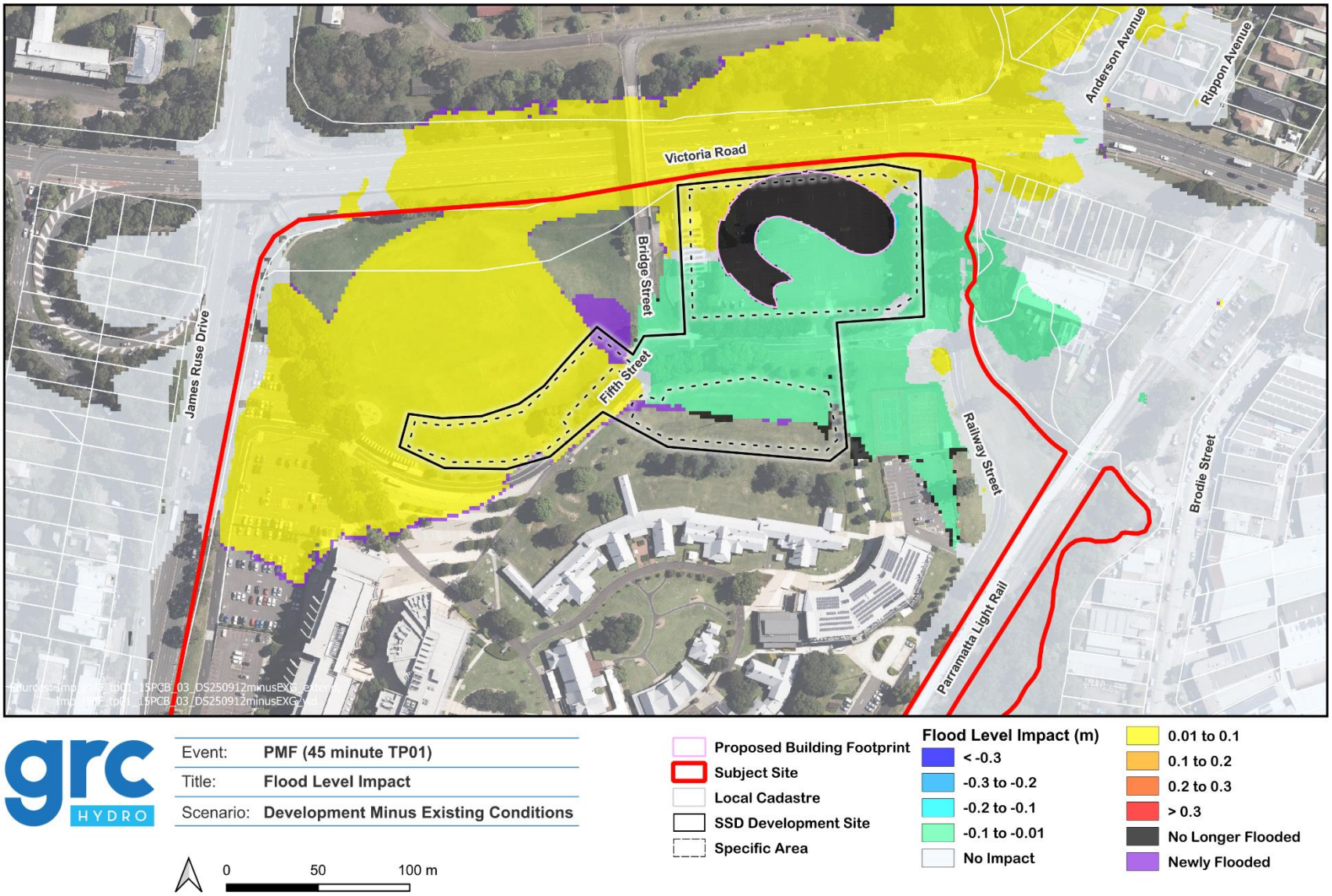


Figure 62: Flood Level Impact – PMF – Developed Condition Minus Existing Condition



7 Flood Emergency Response Plan

7.1 Emergency Response Summary

The SES has provided comment on flood-related reporting that has been previously submitted regarding this proposed development. This updated FIRA and FERP has taken SES comments and suggestions into account and the emergency response has been simplified and early evacuation adopted in response to SES requests.

An emergency response plan has been detailed below and the table below offers a very brief summary of the emergency response approach.

PRIMARY ACTION: Leave or Stay Away When Severe Weather is Predicted	BACK-UP ACTION: Shelter-in-Place: If Occupants do go to the Campus and a Flood Event Occurs, a Flood Alert will Trigger and Demand Occupants Move to the First Floor Immediately
WSU will take advantage of BoM's Severe Weather Warnings and Severe Thunderstorm Warnings as well as BOM's rainfall estimates. If a BoM severe weather (rainfall) or severe thunderstorm warning is issued, and the estimated daily rainfall exceeds 100 mm, WSU will send a text and email to all students and staff to ask them to "Act Now: Leave or stay away from the Indigenous Centre of Excellence until further notice due to a potential flood event at the campus. If your car is parked at the ICoE car park, please drive it off site immediately so that it is not exposed to potential flooding." If rainfall is not predicted to exceed 100 mm then no evacuation order will be issued. This will be accompanied by a recorded announcement at the ICoE that tells people to leave the site and head home. This announcement will be repeated every 5 minutes. WSU already issues alert of this nature so this would just be an addendum to their current practice. WSU staff will inform the SES when this is triggered.	Human behaviour suggests that some people may choose to ignore the initial 'stay away' alert. For those that are present during a flood event, a sump alarm will trigger when flood levels reach the 5% AEP level surrounding the building. The alarm will direct all personnel to move upstairs immediately and wait for further instruction when the floodwaters begin receding. WSU staff will inform the SES when this is triggered.

7.2 Flood Emergency Context

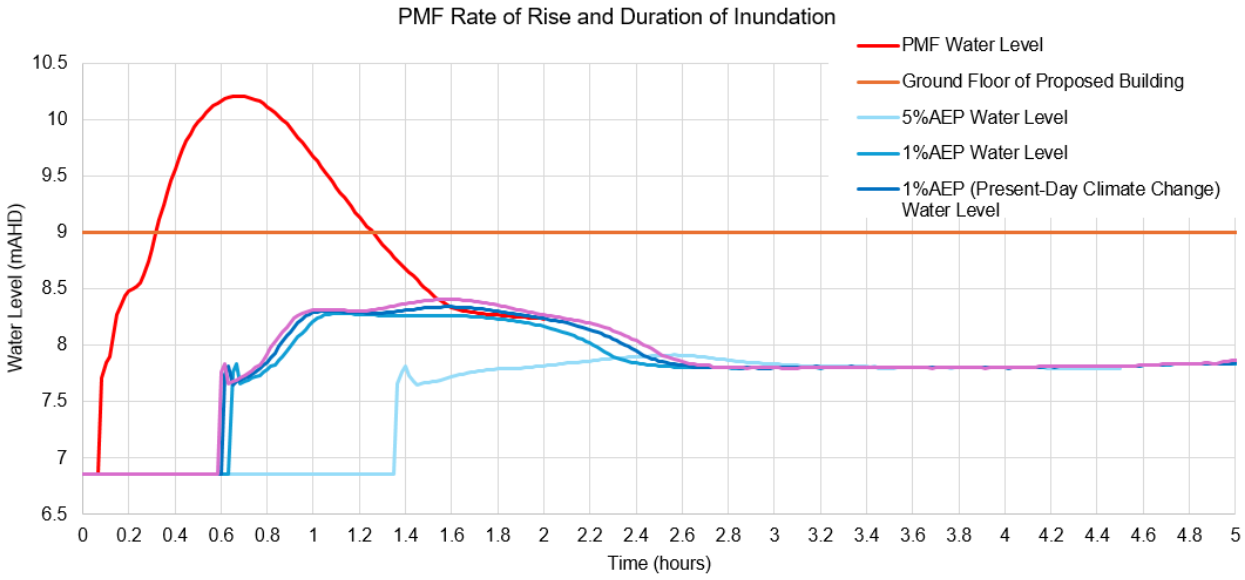
The proposed building will have a finished floor level of 9.0 mAHD. This is approximately 0.5 m higher than the 1% AEP event (inclusive of present-day climate change) at this site.

In a 1% AEP design flood event, and in a 0.2% AEP event, the southern entrance to the building (at 9.0 mAHD) remains well above the flood level and an accessible (on foot and by wheelchair) connection remains to the south of the building which remains flood free in this design event.

In the course of an event occurring, the exact magnitude of the event that's occurring (5% AEP, 1% AEP, 0.2% AEP etc.) will not be clear. In a PMF design flood event, the rate of rise of flood waters is relatively quick (only ~21 minutes for waters to rise above the finished floor level – see Chart 1) so little warning time is available to safely administer an evacuation process once a flood event begins.

Accordingly, an early warning trigger that relies on BoM severe weather and severe thunderstorm warnings together with BoM's rainfall estimates has been adopted to ensure that no one is present at the ICoE when flooding occurs. A shelter-in-place strategy has been retained as a back-up measure so that occupants who have chosen to ignore previous warnings are not exposed to the risk of being caught in floodwaters. This is a flood emergency response that is commonplace for developments in the City of Parramatta LGA.

Chart 1: PMF Rate of Rise and Duration of Inundation



The duration of inundation in this extreme PMF event is less than 1 hour. Whilst the emergency response intends for the site to be vacant in a flood emergency, if there are people remaining at site when flooding occurs, this is a manageable period in which they can safely and calmly shelter in place.

7.3 Parramatta River Flooding

The proposed building will have a finished floor level of 9.0 mAHD. This remains well above the PRFS 2024 Parramatta River flood level (~3.3 mAHD) in a 1% AEP flood event. GRC did not model riverine Parramatta River flooding as part of this study so GRC have deferred to the PRFS 2024 results for mainstream flooding of Parramatta River.

In aid of determining the site's duration of inundation in a Parramatta River PMF event, along with the predicted rate of rise, a PMF hydrograph has been generated using the following as a basis:

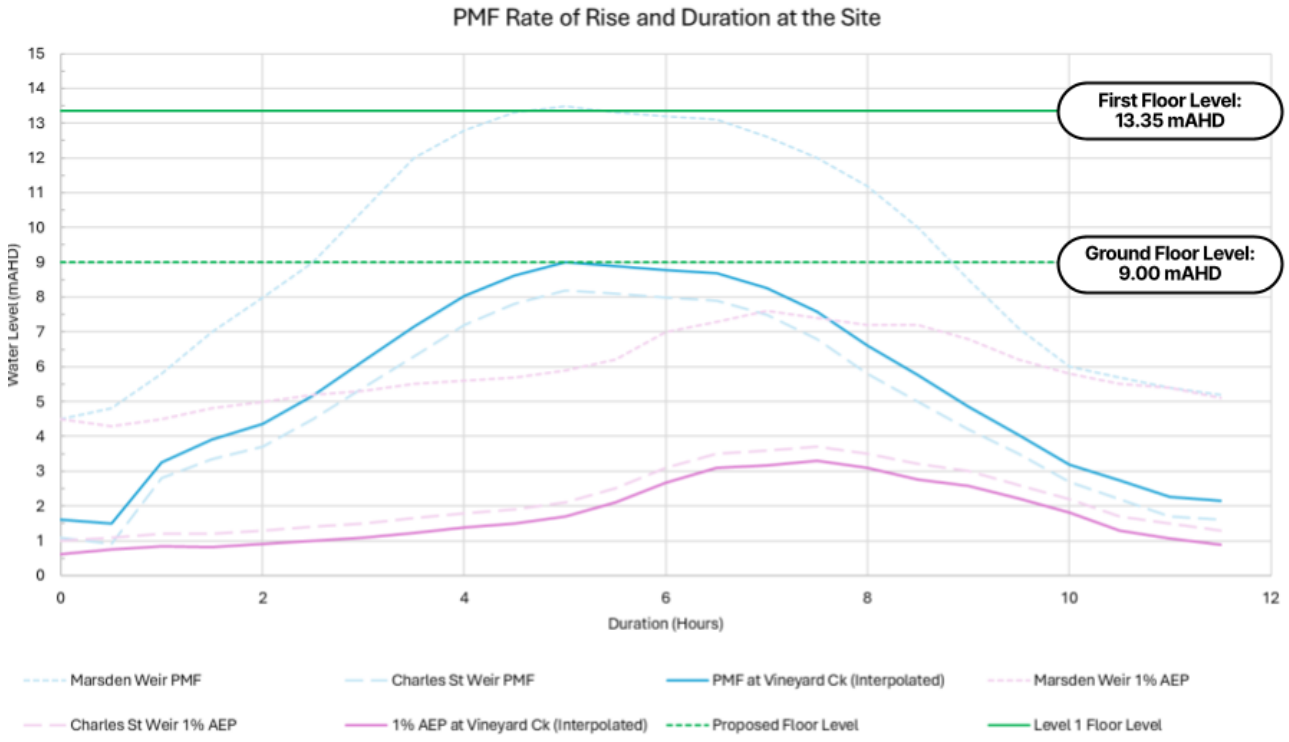
- Two PMF hydrographs provided for Parramatta River at Marsden Weir and Charles St Weir in the *Update of Parramatta Floodplain Risk Management Plans* (Molino Stewart, October 2021); and
- the PRFS 2024 modelled riverine PMF flood level at Vineyard Creek.

The hydrograph in Chart 2 below documents predicted PMF behaviour at the site with notable features being that:

- During a riverine PMF event the flood level does not exceed the proposed FPL of 9.0 mAHD; and
- The rate of rise in a PMF event is in the order of 1.5 m per hour with it taking approximately 5 hours from when flooding starts before the ground floor would become inundated during a PMF event.

Additionally, the riverine PMF peak (5 hours from commencement) does not coincide with the modelled PMF peak at the site (less than 2 hours from commencement).

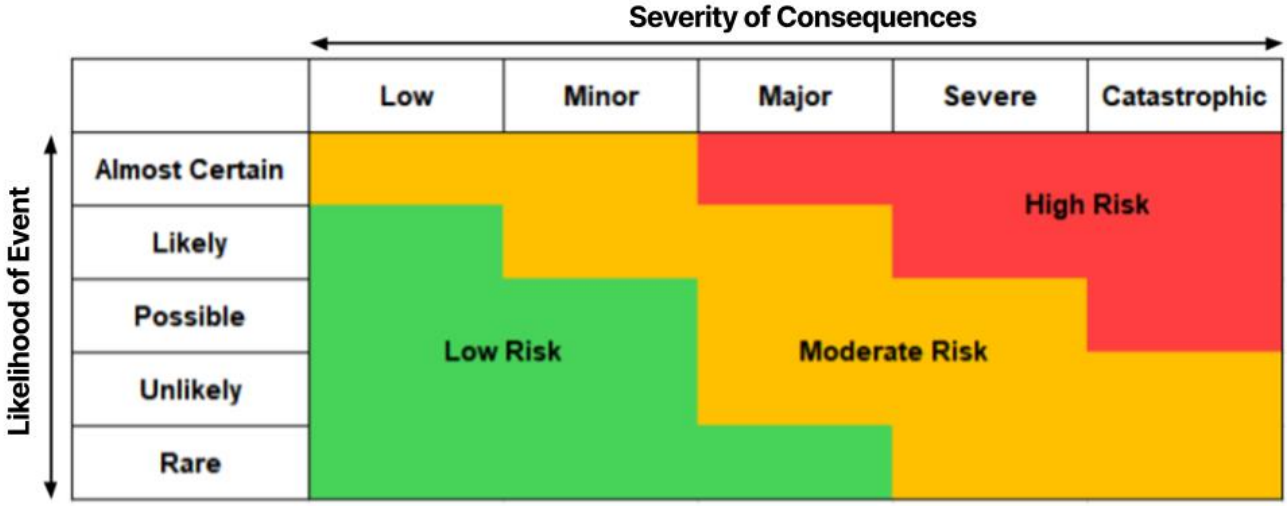
Chart 2: Parramatta River PMF Rate of Rise and Duration of Inundation



7.4 Flood Risk Assessment

GRC has assessed the risks posed by flooding on property, life and the environment. This assessment outlines the potential consequences posed by flooding events of varying likelihoods. The risk is a product of the likelihood and the severity of consequences and the relationship between risk, likelihood (probability) and consequences is outlined in the following diagram.

Figure 63: Relationship between Likelihood, Severity of Consequences and Risk:



The resulting risk matrix is documented below.

Table 6: Risk Matrix – Risks to Property, Life and Environment

Factor	Likelihood (Probability)		Consequences		Risk
Property Damage	Likely	20% AEP flood event	Low	In a 20% AEP event, the flood affectation is minor and is unlikely to have any impact on the physical building. A small amount of scour may occur in this event but the damages incurred are likely to be insignificant.	Low Risk
	Unlikely	1% AEP flood event	Minor	The 1% AEP flood level remains lower than the finished floor level of the proposed development. The proposed development is to be constructed from flood safe materials in a manner to withstand 1% AEP flood forces. The landscaping may be affected by flooding and this could incur damages.	Low Risk
	Rare	PMF flood event	Major	No damage to the structure itself expected but internal equipment (computers, electrical equipment, carpets and glass panels) may need replacing. The landscaping is likely to be damaged as a result of very rare PMF flooding.	Low Risk

Factor	Likelihood (Probability)		Consequences		Risk
Risk to Life	Likely	20% AEP flood event	Low	In a 20% AEP event, flooding at the site will be low, not reach the ground level and will remain concentrated in non-pedestrian areas. Unlikely that harm to life will occur at this site. When BoM issues a Severe Weather Warning (Rain) or a Severe Thunderstorm Warning for Sydney, and the estimated daily rainfall exceeds 100 mm, an early Act Now alert will be issued directing people to leave the site immediately or stay away This early trigger is intended so that all people leave much earlier than flooding commences so that no one is on site during flooding and that they're clear of flood-affected areas during the evacuation process. A back-up shelter-in-place procedure has been retained to direct any remaining occupants upstairs well above the PMF level away from floodwaters.	Low Risk
	Unlikely	1% AEP flood event	Minor	In a 1% AEP event, flooding at the site will be major however it will not reach the ground level and will largely remain concentrated in non-pedestrian areas. It's unlikely that harm to life will occur at this site as occupants on site. When BoM issues a Severe Weather Warning (Rain) or a Severe Thunderstorm Warning for Sydney, and the estimated daily rainfall exceeds 100 mm, an early Act Now alert will be issued directing people to leave the site immediately or stay away This early trigger is intended so that all people leave much earlier than flooding commences so that no one is on site during flooding and that they're clear of flood-affected areas during the evacuation process. A back-up shelter-in-place procedure has been retained to direct any remaining occupants upstairs well above the PMF level away from floodwaters.	Low Risk

Factor	Likelihood (Probability)		Consequences		Risk
	Rare	PMF flood event	Minor	In a PMF event, the consequences of flooding could be significant however an early Act Now trigger for evacuation is intended so that no-one is present when flooding occurs. When BoM issues a Severe Weather Warning (Rain) or a Severe Thunderstorm Warning for Sydney, and the estimated daily rainfall exceeds 100 mm, an early Act Now alert will be issued directing people to leave the site immediately or stay away This early trigger is intended so that all people leave much earlier than flooding commences so that no one is on site during flooding and that they're clear of flood-affected areas during the evacuation process. A back-up shelter-in-place procedure has been retained to direct any remaining occupants upstairs well above the PMF level away from floodwaters.	Low Risk
Environmental Harm	Likely	20% AEP flood event	Low	The site is proposed at an existing hardstand site that is topographically disconnected from Vineyard Creek's riparian corridor. Flooding at the site, especially in small events, is unlikely to result in environment damage and the potential for environmental damage is certainly not exacerbated by the introduction of the new development. Any hazardous goods stored at the site will be well above the 1% AEP level plus 0.5 m freeboard.	Low Risk
	Unlikely	1% AEP flood event	Low	The site is proposed at an existing hardstand site that is topographically disconnected from Vineyard Creek's riparian corridor. Flooding at the site, especially in small events, is unlikely to result in environment damage and the potential for environmental damage is certainly not exacerbated by the introduction of the new development. Any hazardous goods stored at the site will be well above the 1% AEP level plus 0.5 m freeboard.	Low Risk

Factor	Likelihood (Probability)		Consequences		Risk
	Rare	PMF flood event	Minor	The site is proposed at an existing hardstand site that is topographically disconnected from Vineyard Creek's riparian corridor. Flooding at the site, especially in small events, is unlikely to result in environment damage and the potential for environmental damage is certainly not exacerbated by the introduction of the new development. Any hazardous goods stored at the site will be well above the 1% AEP level plus 0.5 m freeboard. Whilst these could be impacted in a PMF event, the volume of hazardous goods present on the site as the proposed development will not have any labs so the need for a large volume of chemicals is low.	Low Risk

Whilst the site is flood liable, the proposed development has been designed to limit risk to life and as such the residual risk remains low or moderate for the reasons explained in the table above.

7.5 Emergency Management Approach

A summary of the proposed flood emergency management approach is as follows:

- Preparation – To be undertaken at regular intervals, making sure that staff are aware of flooding issues and emergency procedures as well as making sure that the requisite emergency supplies are stocked and that emergency backup systems are working properly. During these preparation sessions, staff will be reminded that the SES are the combat agency responsible for flood emergency response (as per the Parramatta Local Emergency Management Plan) and they can be contacted via the following:
    - For non-emergency or general enquiries, call 138 737.
    - For emergency assistance during a flood, storm or tsunami, call NSW SES on 132 500

- Warning Systems –BoM weather warnings form the primary trigger. Two sump alarms will be installed at the site to trigger an alarm. These are to be set at the 5% AEP level. Both will be fitted with battery back-ups and be separated from each other so that there is redundancy in the system. The proposed location of the sump alarms are identified in the "Sump Alarms" section below.

- When Extreme Weather is Predicted – When extreme weather is predicted, the campus has an existing emergency management strategy that includes sending staff and students a text or email that asks them to stay away from the campus if their presence at the University is non-essential (i.e. if lectures, tutorials and functions can be conducted remotely).

  It has been recommended that this is strengthened for the ICoE and staff and students are told to stay away or leave the site when a BoM severe weather (rainfall) or severe thunderstorm warning is issued, and the estimated daily rainfall exceeds 100 mm. If rainfall is not predicted to exceed 100 mm then no evacuation order will be issued.

  This will be supported by a recorded loudspeaker message that will be sounded at the ICoE informing all occupants that they need to leave. This will repeat at 5 minute intervals.

  The goal of this is that the ICoE is empty if a flash flooding event occurs.

- Shelter-in-Place (Back-Up Emergency Strategy in case Occupants are still on-site) – In the event that some people insist on coming to the ICoE against advice, an alarm-led Shelter-in-Place system exists as a backup.

  When floodwaters are identified as rising in the site's forecourt, a sump sensor will trigger an alarm. This will provide clear instructions for all staff and occupants to immediately move upstairs to level one.

  The proposed development has been designed to be flood-resilient and to safely accommodate occupants well above the design flood level in all events.

  Emergency supplies will be assured through operation and maintenance procedures. The vast majority of flood events at this site will not reach the ground floor level (the 1 in 500 year level

The proposed development is a good candidate for sheltering in place as the new building has been designed to withstand flood forces, ample space is provided (at least 8.6 m^2 in the worst case (most populous) scenario) and level 1 lies more than 2.9 m higher than the modelled PMF level.

- Continuous Improvement – Following a flood emergency, however small, responsible staff will review the event and the effectiveness of the actions taken to assure safety. A record of the event should be made which includes the flood depth, time of peak and local rainfall record. Improvements should be made, where appropriate, to improve the effectiveness of the emergency procedures.

7.5.1 Preparation

7.5.1.1 Responsibility of WSU Management

WSU Management shall appoint a senior member of ICoE staff to be responsible for flooding issues. This member of staff will advocate for emergency flood measures and WSU Management's responsibility in this relationship is to liaise with this ICoE flooding advocate and provide adequate funds and support to maintain flood emergency systems, measures and provisions.

7.5.1.2 Responsibility for Coordination

A senior flood warden needs to be appointed to manage and maintain flood emergency preparation measures. This can be a member of staff and ideally would be the responsibility of the building manager. The flood warden would be responsible for the following:

- Briefing and deputising other senior members of staff to act as flood wardens to help communicate flood emergency procedures and issues to other staff and occupants. These flood wardens may be relied upon to help coordinate flood emergency response measures if the senior flood warden is not on site at the time of flooding.

- Liaising with local SES staff to ensure that the building's FERP aligns with their preferences for local flood emergency management. Staff will be reminded that the SES are the combat agency responsible for flood emergency response (as per the Parramatta Local Emergency Management Plan) and WSU staff should act in conjunction with SES evacuation orders in the event of an emergency. The SES can be contacted via the following:
    - For non-emergency or general enquiries, call 138 737.
    - For emergency assistance during a flood, storm or tsunami, call NSW SES on 132 500

- Undertaking quarterly checks of emergency systems such as:
    - The text and email system (which is currently existing)
    - the flood warning system (an alarm and public announcement system);
    - the sump sensor alarms
    - emergency provision of suitable food,
    - personal washing facilities,
    - medical equipment including a first aid kit, and
    - a battery-powered radio and relevant communications equipment.

- **Check signage** and make sure that it is correctly posted throughout the ICoE.
- **Liaise with Plumbers and Electricians** to undertake post-flooding checks of building systems.
- **Maintain and improve the Flood Emergency Response Plan** as required.

7.5.1.3 Signage

Signage will be positioned throughout the building, most notably the ground floor, that communicates that:

- The building is flood liable and that occupants shall follow instructions in the event of flooding; and
- In the event of a flood emergency, occupants are able to follow the routes identified on an accompanying map to safely shelter on Floors 1 to 3.

Specific signage will be provided in more detail at the detailed design phase.

7.5.1.4 Emergency Supplies and Provisions

The development's operation and management procedures shall ensure the following emergency supplies and back-up systems are stocked (on level one or higher, above the PMF level) and/or functioning correctly.

- Emergency electricity supply, and lighting,
- Clean water for drinking, washing and toilet flushing,
- Working bathroom and toilets,
- A stock of suitable food which may include:
    - Canned vegetables (e.g., green beans, carrots)
    - Canned fruits (e.g., peaches, mandarin oranges)
    - Canned proteins (e.g., tuna, salmon, chicken, beans)
    - Canned soups or stews
    - Shelf-stable milk (powdered or cartons)
    - Instant oats
    - Whole-grain crackers
    - Pre-cooked rice packets or instant rice
    - Pasta or couscous (quick-cooking varieties)
    - Nut butter (e.g., peanut butter, sunflower seed butter; single-serving packets if nut-free)
    - Granola bars or protein bars
    - Dried fruits (e.g., raisins, apricots)
    - Trail mix (nut-free if needed)
    - Dark chocolate (for energy and comfort)
    - Bottled water (at least 2 litres per person per day)
    - Electrolyte drinks or powder mixes
    - Instant noodles or cups of soup
    - Comfort snacks (e.g., cookies, biscuits)
    - Manual can opener
- Personal washing facilities,
- Medical equipment including a first aid kit,
- A battery-powered radio and relevant communications equipment, and
- A comfortable, safe, indoor, sheltered environment.

7.5.2 Warning Systems

7.5.2.1 Email and Text System

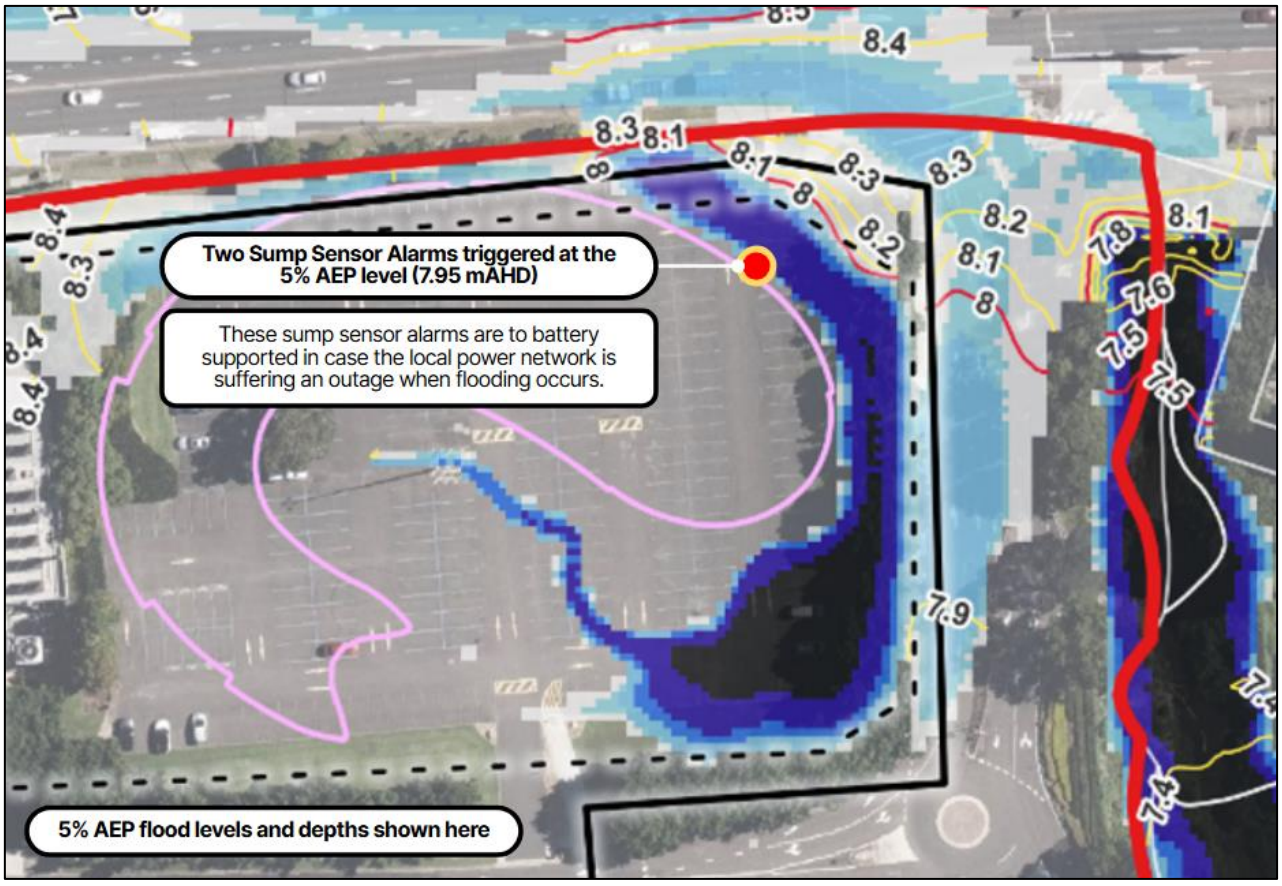
WSU will take advantage of BoM's Severe Weather Warnings and Severe Thunderstorm Warnings as well as BOM's rainfall estimates. If a BoM severe weather (rainfall) or severe thunderstorm warning is issued, and the estimated daily rainfall exceeds 100 mm, then an automated email and text will go out to all relevant ICoE staff, students and stakeholders telling them to either evacuate or stay away from the campus. If rainfall is not predicted to exceed 100 mm then no evacuation order will be issued.

- Evacuate if they're presently at the campus; and
- Stay away from the campus until further notice.

7.5.2.2 Sump Alarms

Two battery-supported sump alarms will be fitted at the building's north-eastern corner. These will be set to trigger an alarm when floodwaters reach the 5% AEP level.

Figure 64: Location of Sump Alarms



7.5.2.3 Alarm and Public Announcement Systems

The proposed building will have an alert system to inform occupants of the actions they are required to take in the event of flooding.

This will take the form of an alarm and a voiceover (with additional public announcement system for backup) to relay specific instructions on where occupants should move to evacuate or shelter.

When a Severe Weather Warning or Severe Thunderstorm Warning has been issued by BoM and the estimated daily rainfall exceeds 100 mm. WSU will email and text staff and students asking them to stay away from the ICoE, the PA system at the site will announce every 5 minutes: "*A severe weather warning is in place for this building. Please leave the campus and head home*."

The alarm system, once triggered by the sump device will:

- Sound a loud siren
- Use flashing lights to alert occupants who are hard of hearing.
- Sound the following loud message over the battery-supported PA system:

  A flood warning has been activated.

  If you are on the ground floor, move to the first floor immediately.

  Occupants are not to leave the site on foot. You are not to use vehicles and attempt to leave the site as floodwaters may pose a threat to life.

  Anyone outside the building is to come inside and move upstairs immediately as the external doors will be locked in 8 minutes time. (This is to be repeated every two minutes indicating the remaining number of minutes until the cut-off.)

  People with mobility issues have priority for use of lifts and others should use the stairwells.

  Lift usage will cease in 8 minutes time so please act now. (This is to be repeated every two minutes indicating the remaining number of minutes until the cut-off.)

  People with mobility issues should identify themselves to others and seek assistance from others.

  Once you are on level one or above, rest assured that flood events can pass quickly and you will be able to return to the ground level when flood waters recede.

  You will be informed when it is safe to return to the ground floor and/or leave the building.

7.5.3 Ensuring the Campus is Empty when Severe Weather is Predicted

When extreme weather is predicted, the campus has an existing emergency management strategy that includes sending staff and students a text or email to ask them to stay away from the campus. This is intended to ensure the ICoE is empty if a flash flooding event occurs.

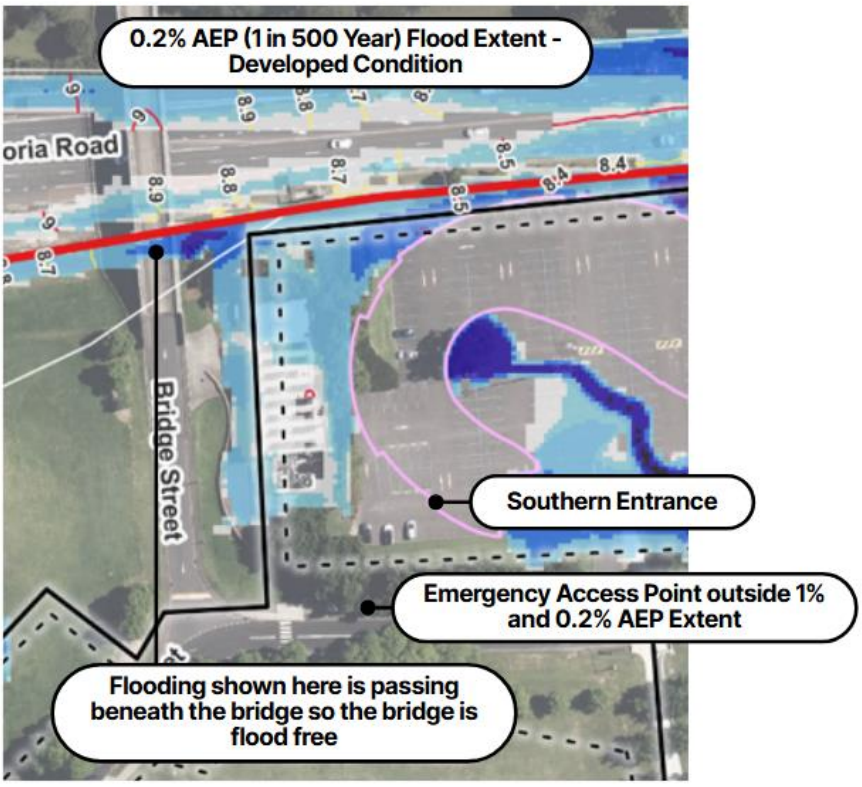
7.5.4 Emergency Access for Secondary Medical Events

Evacuation in a medical emergency is possible for this site even in a 0.2% AEP event as a flood free access route is available via Bridge St. Given the flood liability of the broader Parramatta River area, evacuation should be reserved for emergency services drivers with the experience to manage the situation appropriately.

The emergency response process is designed so that no-one is at this site in the event of a flood emergency yet this contingency plan exists in the event that someone remains at the site during a flood emergency

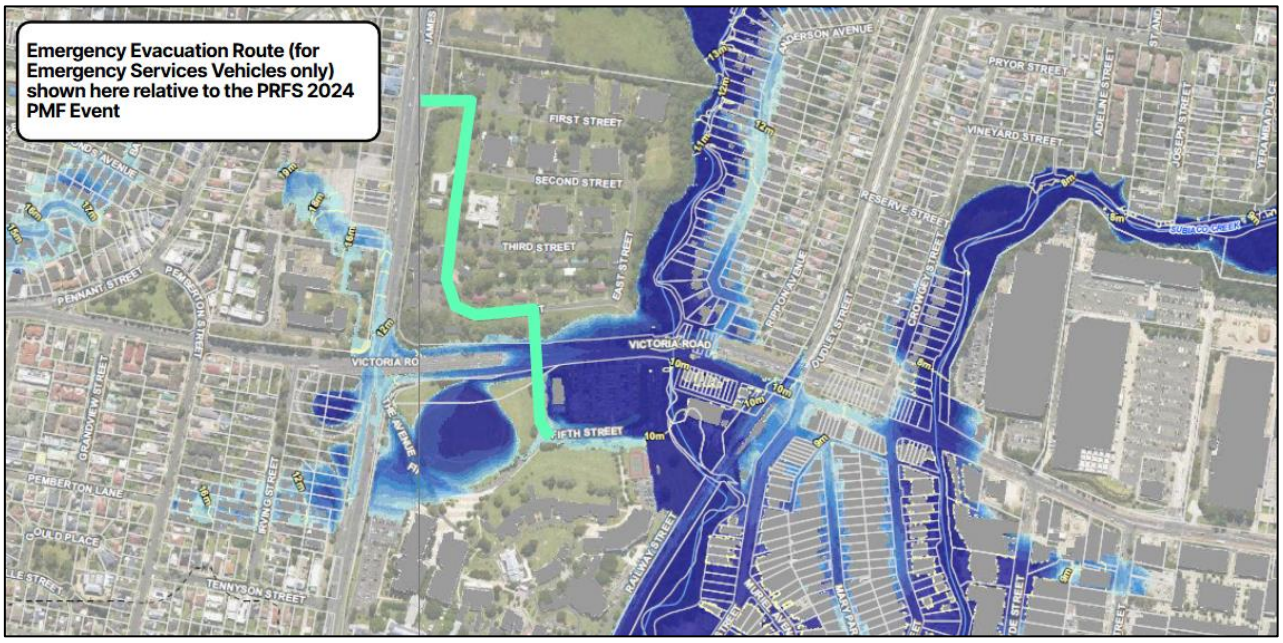
An emergency access point above the 1% AEP flood level (and 0.2% AEP level) is located immediately south of the proposed building's southern entrance. This location is identified in the figure below.

Figure 65: Emergency Access Point (above the 1% AEP and 0.2% AEP Flood Level)



In a PMF, the nominated emergency access point is inundated for only a short period. When a PMF event is occurring, emergency services crews will use caution and ensure that this area is flood-free before proceeding to the site.

Figure 66: Emergency Access Route (PRFS PMF flood mapping has been used here to include potential flooding outside the GRC study area)



7.5.5 Shelter-in-Place (a Back-Up Strategy)

7.5.5.1 Shelter-in-Place Refuge Area

The proposed building is a public education facility with generous provision of indoor space for congregation. Floors 1 to 3 will all be elevated above the PMF level. Evidence of this is attached in the architectural plans attached in Appendix B.

Each of these floors has approximately 3,200 m^2 of accessible space that can be used for refuge in a flood emergency situation. This is approximately 9,600 m^2 in total.

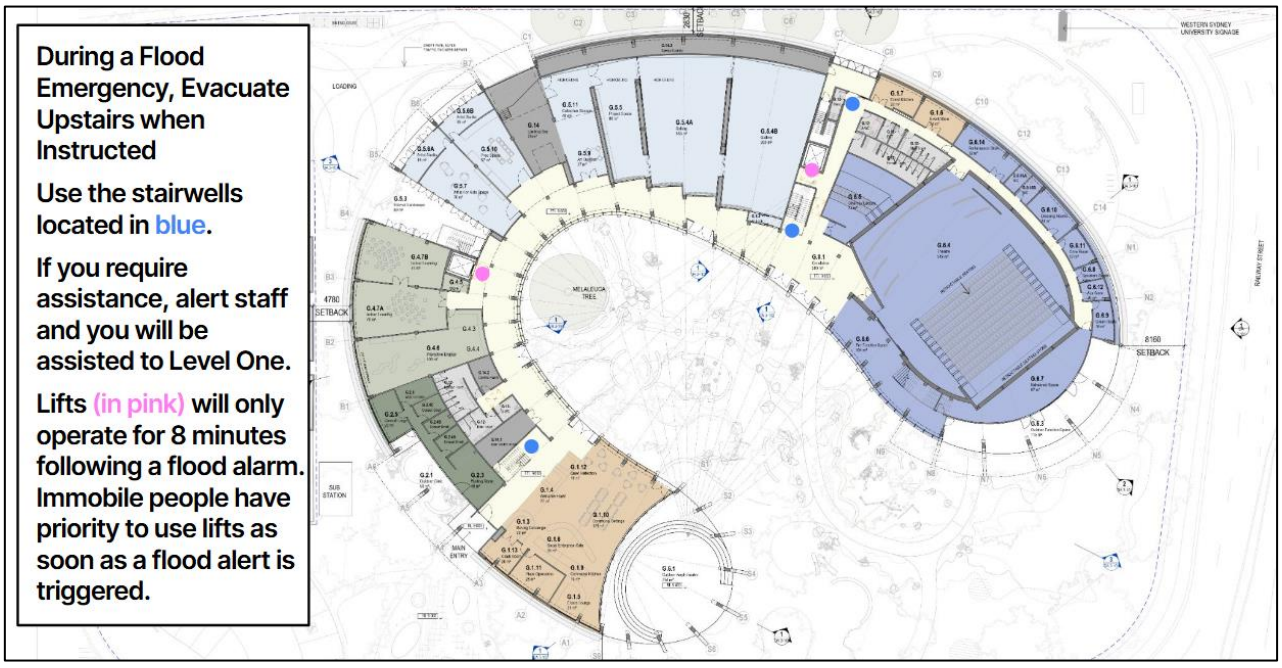
WSU has estimated occupancy numbers for the ICoE that range between 535 people on a weekend day, to 669 people on a regular weekday to 1,114 people for a once-in-six-month event. The event scenario is the highest occupancy prediction. If a flood event were to occur during such a scenario, and if for some reason, all occupants chose to ignore the prior warnings to leave or stay away from the ICoE, each person would have 8.6 m^2 of space to comfortably wait out the 1 hour period

7.6 Going Upstairs to Level One to Shelter-in-Place Refuge Area

Building management shall create a map identifying routes for people to go upstairs to level one to be used in the event of a flood emergency. A suggested example of such a map is below. This map shall feature clear guidance to users on how they should evacuate when instructed.

Stairwells are to be the primary route to move upstairs to level one. For immobile occupants, lifts will continue to operate for 8 minutes after the sump alarm is sounded. Immobile occupants should seek help from others to get to the lifts immediately. After the 8 minute period, lifts will be parked and locked on level one so that the lifts cannot enter PMF floodwaters should the ground level become overtopped.

Figure 67: Example Flood Evacuation Route Map



7.6.1 Continuous Improvement

Following a flood emergency, however small, responsible staff will review the event and the effectiveness of the actions taken to assure safety. A record of the event should be made which includes the flood depth, time of peak and local rainfall record. Improvements should be made, where appropriate, to improve the effectiveness of the emergency procedures.

7.7 Emergency Procedure

GRC suggest the following Flood Emergency Response Procedure for the ICoE.

1. **Consult Local Warnings**: If heavy rainfall is predicted for Sydney, flood wardens should refer to the Bureau of Meteorology's (BOM) Warnings for NSW at the following website: http://www.bom.gov.au/products/warn_nsw.shtml. WSU currently triggers alerts based on this information and this shall be adopted and strengthened for the ICoE.
2. **Issue an Automated Email/Text Alert when triggered by a Severe Weather Warning (and the estimated daily rainfall exceeds 100 mm) or Severe Thunderstorm Warning** that tells staff, students and guests to leave the site, or not go to the site. This is designed so that no one is on site in the event of flash flooding and the adoption of this early trigger is designed so that all early evacuees can leave the local, flood-affected areas before flooding occurs.
3. **Liaise with the SES:** When an early evacuation is issued, a WSU representative will call the SES on 132 500 to inform them that an early Act Now evacuation trigger has been issued and the ICoE is being cleared.

   The SES are the combat agency responsible for flood emergency response (as per the Parramatta Local Emergency Management Plan) and WSU staff should act in conjunction with SES evacuation orders in the event of an emergency. If the local situation at the site appears unsafe for evacuation

(if staff can see fast and deep water flowing over Victoria Road, staff should exercise judgement and rely upon shelter-in-place. The SES can be contacted via the following:

- For non-emergency or general enquiries, call 138 737.
- For emergency assistance during a flood, storm or tsunami, call NSW SES on 132 500

4. Sump Alarms Trigger an Automated Back-Up Shelter-in-Place Alert Procedure at the 5% AEP Level
    - If flooding has risen to the 5% AEP flood level a voiceover alert will sound to inform occupants that:

      A flood warning has been activated.

      If you are on the ground floor, move to the first floor immediately.

      Occupants are not to leave the site on foot. You are not to use vehicles and attempt to leave the site as floodwaters may pose a threat to life.

      Anyone outside the building is to come inside and move upstairs immediately as the external doors will be locked in 8 minutes time. (This is to be repeated every two minutes indicating the remaining number of minutes until the cut-off.)

      People with mobility issues have priority for use of lifts and others should use the stairwells.

      Lift usage will cease in 8 minutes time so please act now. (This is to be repeated every two minutes indicating the remaining number of minutes until the cut-off.)

      People with mobility issues should identify themselves to others and seek assistance from others.

      Once you are on level one or above, rest assured that flood events can pass quickly and you will be able to return to the ground level when flood waters recede.

      You will be informed when it is safe to return to the ground floor and/or leave the building.."

5. Sump Alarms Trigger a "Safe to Leave" Announcement at the 5% AEP Level
    - At the 5% AEP level, flood waters should have receded from Victoria Road and surrounding areas. When the water falls to the 5% AEP flood level, the sump alarm will trigger an announcement that alerts sheltering occupants that: "*It is now safe to return to the ground floor. Please call the SES on 132 500 to ask whether the roads around the Campus and Parramatta River are flood-free so that you may safely leave the site via the southern, ground floor entrance*."
6. Survey Post-Flood Damage: Following a flood emergency event, flood wardens should survey the ground floor and landscaping to identify any damage or issues that may have resulted due to flooding.
7. Initiate a Building Check by asking the building's plumbing and electrical contractor to do a check of the building to ensure that the building's systems are not damaged and are in working order.
8. Flood Warden Debrief: the senior flood warden should convene a meeting of all wardens present to share observations about the flood emergency event and highlight improvements that can be made to the procedure(s).

7.8 Flood Emergency Drills

Annual Flood Emergency Drills should be conducted. This will allow for the alarm system to be tested and conduct a drill of a shelter-in-place procedure as follows:

- *Step 1*: Issue a test email, text and alarm to ensure that the email/text warning system is working and will work when triggered by a Bom Severe Weather Warning (Rain) for Sydney, a Severe Thunderstorm Warning and the estimated daily rainfall exceeding 100 mm or if manually triggered in the event of a SES evacuation order.
- *Step 2*: Trigger the alarm and announcement system. An alarm and warning will sound to direct all occupants to make their way to Level 1 or above immediately. All occupants on Level 1 and above can remain in place and await further instructions.
- *Step 3*: Sound a message over the PA system that all staff and occupants that the drill has concluded may safely return to the building.

7.9 Engagement with the State Emergency Service

The SES has provided comment on flood-related reporting that has been submitted regarding this proposed development. This updated FIRA and FERP has taken SES comments and suggestions into account and the emergency response has been simplified and adopted early evacuation in response to SES requests.

7.10 Emergency Response – Car Park

The emergency response for the car park is the same as the procedure for the ICoE building.

Early evacuation is the primary response with the intention that all occupants (and their cars) will have evacuated the site well in advance of storm activity commencing. Occupants will be able to drive their cars off the site.

Signage should be placed in the car park that makes visitors aware that the site is flood liable and if they happen to be present when floodwaters are rising to the north-east, they should seek refuge in the campus buildings to the south of the car park.

If occupants witness floodwaters surrounding the ICoE building, they should not attempt to drive off site. Instead, they should walk uphill to the south and seek temporary cover in one of the campus buildings south of the carpark – all of which are elevated higher than the PMF level.

Image 3: Carpark overlap with 0.2% AEP Flood Hazard

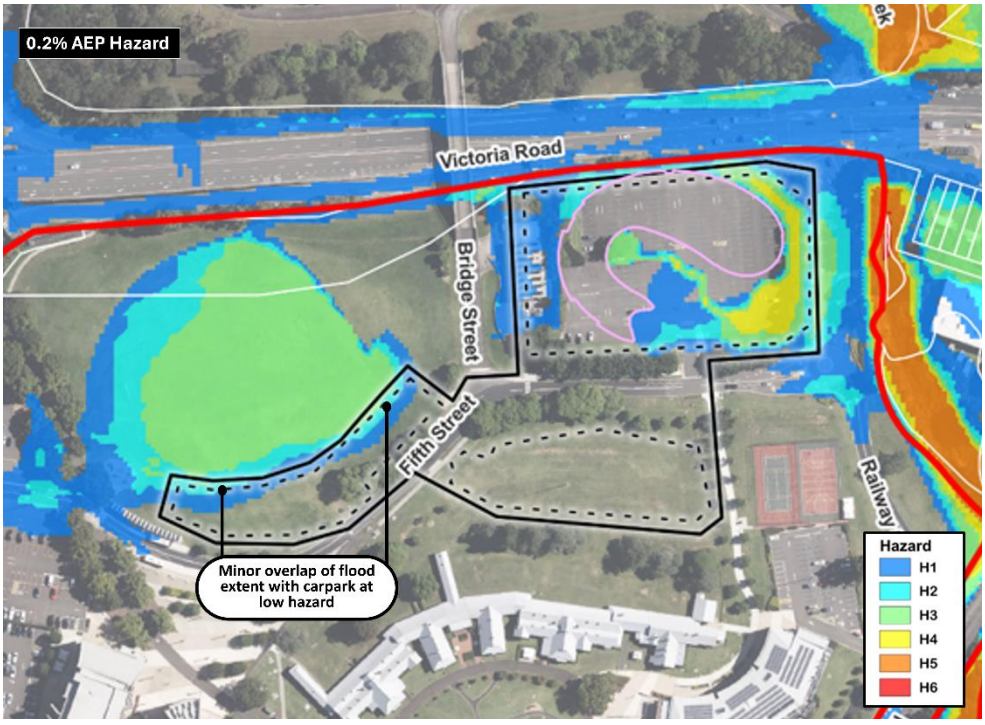
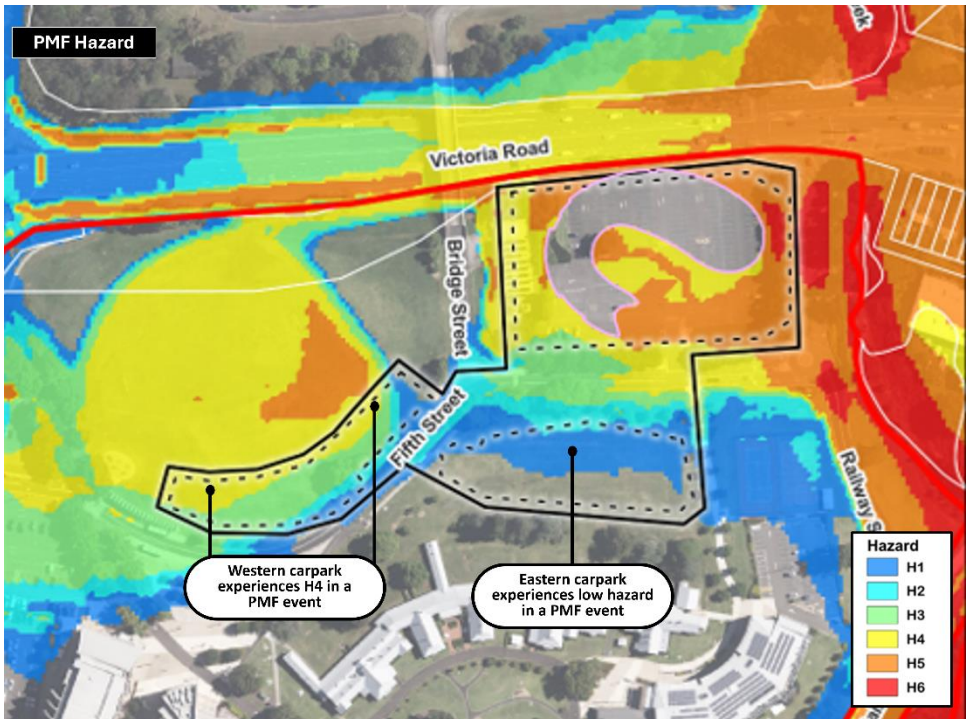


Image 4: Carpark overlap with PMF Flood Hazard



8 Compliance with Flood-Related Planning Controls

The relevant design standards that apply to the proposed development are determined in accordance with the following planning controls:

- The Parramatta Development Control Plan (DCP) (2023); and
- The Parramatta Local Environment Plan (LEP) (2023).

The hazard map (Figure C2) that Council provided for the site excludes Vineyard Creek (see Appendix A). As such, GRC has derived a flood hazard for the site by modelling the hydraulic hazard at the site as per the method outlined in Appendix L of the Floodplain Development Manual. In the 1% AEP event, the site is primarily subject to low hydraulic hazard with a small pocket of high hazard in the south-eastern corner, as documented in Figure 55 below. As such, GRC has conservatively classified the subject site as medium flood hazard.

Figure 68: Hydraulic Hazard (calculated in accordance with Floodplain Development Manual, Appendix L)



8.1 Planning Control Compliance Requirements

The primary flood-related planning requirements for the site are outlined in the following planning instruments:

- The Parramatta Development Control Plan (2023) as it applies to University (Commercial) development; and
- The Parramatta Local Environmental Plan (2023) 5.21 and 7.11 as it applies to University (Commercial) development.

These flood-related controls (PDCP 2023, Section 5.1.1 and LEP) are outlined below in addition to comments to summarise how the proposed development addresses each control.

8.1.1 Parramatta Development Control Plan (2023)

Guidance on which flood-related controls are relevant to each individual development is outlined under Section 5.1.1- C.24.

GRC has outlined the flood-related controls relevant to this site and the proposed land use in the following tables.

Table 7: Land Use Category Definitions (Table 5.1.1.1 from the PDCP, 2023)

Table 5.1.1.1 – Land Use Category Definitions

Land Use Categories	Identifies Land Uses
Sensitive uses and facilities	• Community facilities or Public administration buildings which may provide an important contribution to the notification and evacuation of the community during flood events; • Early education and care facilities; • Hospitals; • Residential care facilities; • Seniors housing; • Educational establishments, • Emergency services facilities.
Critical uses and facilities	• Hazardous industries; • Heavy industrial storage establishments; • Offensive industries; • Public utility undertakings which may cause pollution of waterways during flooding, are essential to evacuation during periods of flood or if affected during flood events would unreasonably affect the ability of the community to return to normal activities after flood events; • Telecommunication facilities; • Waste management facilities.
Residential	• Attached dwellings; • Backpackers accommodation; • Bed and breakfast establishments; • Boarding houses; • Camping grounds; • Caravan parks; • Community facilities (other than sensitive uses/facilities); • Dual occupancies; • Dwelling houses; • Group homes; • Health consulting rooms; • Home based child care; • Home businesses; • Home industries; • Home occupations; • Hostels; • Multi dwelling housing; • Neighbourhood shops; • Residential flat buildings; • Secondary dwellings; • Semi-detached dwellings; • Serviced apartments; • Public utility undertakings (other than critical uses and facilities).
Commercial or Industrial	• Advertising structures; • Agriculture; • Amusement centres; • Business Premises; • Car parks; • Correctional centres; • Crematorium; • Depots; • Entertainment facilities; • Food and drink premises; • Freight transport facilities; • Funeral homes; • Function centres; • Hardware and building supplies; • Health consulting rooms; • Heavy industries; • Hotel accommodation; • Industries; • Information and education facilities; • Industrial retail outlets; • Kiosks; • Landscape and garden supplies; • Light industries; • Markets; • Materials recycling or recovery centres; • Medical centres; • Mixed-use development; • Mortuaries; • Office premises; • Passenger transport facilities; • Places of public worship; • Public administration buildings (other than essential uses and facilities); • Pubs; • Recreation facilities (indoor); • Recreation facilities (major); • Registered clubs; • Restricted premises; • Retail Premises; • Service stations; • Sex services premises; • Shop top housing; Signage; Specialised retail premises; • Storage premises; • Transport depot; • Truck depot; • Tourist and visitor accommodation; • Vehicle body repair workshops; • Vehicle repair stations; • Vehicle showrooms; • Veterinary hospitals; • Warehouse or distribution centres; • Waste or resource management facilities; • Wholesale supplies.
Open space or Non-urban uses	• Animal boarding and training establishments; • Boat launching ramps; • Boat repair facilities; • Boat sheds; Cemetery; • Charter and tourism boating facilities; • Environmental facilities; • Environmental protection works; • Helipad; • Jetty; • Marinas; • Mooring; • Port facilities; • Water recreation structures; • Recreation areas and minor ancillary structures (e.g. Toilet blocks or kiosks); • Recreation facilities (outdoor)
Subdivisions	Subdivision of land which involves the creation of additional allotments.
Filling of flood prone land	The net importation of fill material onto a flood prone site is not permitted, except where: i) final surface levels are raised by no more than 100mm over no more than 50% of the site; or ii) filling is to be no more than 800mm thick beneath a concrete building slab, provided this does not significantly affect the floodway conveyance or flood storage.
Concessional Development	Concessional development is any development or redevelopment that would normally not be permitted under this Plan, but may be permitted as a concession provided it: i) is kept clear of any floodway; and ii) involves an acceptably small (see below for limits) addition or alteration to an existing development that will not cause a significant increase in potential flood losses, risks or have an adverse impact on adjoining properties; or iii) redevelopment for the purposes of substantially reducing the extent of flood affectation to the existing building; provided that such redevelopments incorporate to the fullest extent practical, design features and measures to substantially reduce the existing potential for flood losses and personal risks, and avoid any adverse impacts

The proposed development is classed as an "Information and education facility," therefore it is categorised as a Commercial or Industrial land use.

As outlined above, GRC has assessed the site can be classified as a Medium Flood Risk area.

The Floodplain Matrix in Section 5.1.1 – C.24 of the PDCP (2023) (included as Table 7 below) stipulates which development controls are relevant to a development with this land use and flood risk.

Table 8: Flood-related controls and requirements (Table 5.1.1.2 from the PDCP, 2023)

Table 5.1.1.2 – Floodplain Matrix Planning and Development Controls

Flood Risk Precincts (FRPs)	Planning Consideration	Floor Level	Building Components	Structural Soundness	Flood Affectation	Car Parking & Driveway Access	Evacuation	Management & Design
High Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	X	X	X	X	X	X	X
	Commercial & Industrial	X	X	X	X	X	X	X
	Open Space & Non-Urban	1	1	1	1	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision	X	X	X	X	X	X	X
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	3, 4, 6	2, 3, 4
Medium Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	X	X	X	X	X	X	X
	Residential*	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Commercial & Industrial	2	1	1	1	1, 3, 5, 6, 7	3, 4, 6	2, 3, 4
	Open Space & Non-Urban	1	1	1	2	2, 4, 6, 7	1, 4	2, 3, 4
	Subdivision				1		3, 4, 5	1
	Filling	X	X	X	X	X	X	X
	Concessional Development	4	1	1	1	1, 5	2, 5	2, 3, 4
Low Flood Risk	Sensitive Uses & Facilities	X	X	X	X	X	X	X
	Critical Uses & Facilities	3	2	2	2	1, 3, 5, 6	2, 4, 6	2, 3, 4
	Residential*	2			2	1, 3, 5, 6	3, 4	
	Commercial & Industrial	2			2	1, 3, 5, 6	4	
	Open Space & Non-Urban					2, 4, 6, 7		
	Subdivision				2		5	1
	Filling				1			
	Concessional Development							

*For redevelopment of existing dwellings refer also to 'Concessional Development' provisions.

Legend | | Not relevant | X | Unsuitable Land Use

i. Freeboard equals an additional height of 500mm.

ii. The flood level is usually the higher of that level adopted by Council for fluvial flooding (from rising rivers, creeks, tributaries) for a 1% Annual Exceedance Probability event (1% AEP), or the modelled overland flow flood level (from rainfall in the local catchment) for an event with the same probability (1% AEP). The Flood Planning Level is usually the 1% AEP Flood Level plus a 500mm freeboard safety factor.

iii. The *Parramatta LEP 2023* identifies development permissible with consent in various zones. Notwithstanding, constraints specific to individual sites may preclude Council granting consent for certain forms of development on all or part of a site. The above matrix identifies where flood risks are likely to determine where certain development types will be considered "unsuitable" due to flood related risks.

iv. Filling of the site, where acceptable to Council, may change the FRP considered to determine the controls applied in the circumstances of individual applications.

v. Any fencing that forms part of a proposed development is subject to the relevant Flood Effects and Structural Soundness planning considerations of the applicable land use category.

vi. Development within the floodplain may be subject to Clause 6.7 Foreshore Building Line in the *Parramatta LEP 2023*.

vii. Additional controls apply to basement carparking within the floodplain, please see Car Park Basements associated controls above.

viii. Where a flood warning and emergency response plan is required, requirements set out below under *'Flood Warning and Emergency Response Planning'* must be achieved.

For a development with:

- Land use: Commercial and Industrial; and
- Flood Risk: Medium

The following flood-related controls (documented in Table 8) apply according to guidance outlined in the matrix tables 5.1.1.2 and 5.1.1.3 in Section 5.1.1 of the PDCP 2023.

Where relevant, GRC has added comment to assist with how to consider these controls during the design process.

Table 9: Flood-Related DCP Controls Relevant to the Proposed Development

Reference	Control	GRC Comment
PDCP 2023 Control (From Table 5.1.1.3)		
Floor Level		
2	All habitable floor levels to be equal to or greater than the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.	All habitable finished floor levels are above 8.99 mAHD (8.49 mAHD + 0.5m freeboard) with a proposed finished floor level of 9.0 mAHD.
Building Components and Method		
1	All structures to have flood compatible building components and construction below the 1% AEP (100 year ARI) flood level plus freeboard.	Separate to this report, a structural engineer will provide guidance on the structural soundness of the proposed concept design. (reference TTW 234338 SAAA).
Structural Soundness		
1	Unless otherwise approved by Council, a structural engineer's report is required to certify that the structure can withstand the forces of floodwater, debris and buoyancy up to and including a 1% AEP (100 year ARI) flood level plus freeboard.	Separate to this report, a structural engineer will provide guidance on the structural soundness of the proposed concept design. (reference TTW 234338 SAAA).
Flood Affectation		
1	A hydraulic engineer's report is required to certify that the development will not increase flood affectation elsewhere, having regard to: (i) loss of flood storage; (ii) changes in flood levels, flows and velocities caused by alterations to flood flows; and (iii) the cumulative impact of multiple potential developments in the vicinity.	This report certifies that the development: (i) No impacts offsite result from the minor loss of flood storage on the subject site of 2,200 cubic metres. Efforts have been made to minimise flood storage loss by landscape works along the eastern portion of the site to compensate for lost volume owing to the establishment of the building. The original design was for an open undercroft however this was not acceptable to Council and hence the slab on ground approach and consequent

Reference	Control	GRC Comment
		minor loss of flood storage now proposed (ii) Flows and velocities remain largely unchanged relative to the existing case with impact mapping used to demonstrate same; (iii) GRC can't attest to the impact of developments other than this proposed building as the development is relatively unique and unlikely to be replicated in the catchment. We can say however that this development's impacts are relatively minor and restricted to the subject site.
Car Parking and Driveway Access		
1	The minimum surface level of unenclosed parking spaces or carports shall be as high as practical, but no lower than 0.1 metres below the 1% AEP (100 year ARI) flood level. In the case of garages and other enclosed parking areas for less than 3 motor vehicles, the minimum surface level shall be as high as practical, but no lower than the 1% AEP (100 year ARI) flood level, plus 0.15 metres freeboard.	13 unenclosed parking spaces are proposed to the south-west of the proposed building. This area is largely unaffected by flooding in the 1% AEP event. 11 of the 13 spaces lie south of the 1% AEP flood extent and the remaining 2 spaces are predicted to have an approximate flood depth ranging from 0.1 to 0.3 m however this area has a low flood hazard of H1 in this and the 0.2% AEP event.
3	Garages, and other enclosed car parking areas, capable of accommodating more than 3 motor vehicles, must be protected from inundation by floods equal to or greater than the 1% AEP (100 year ARI) flood. Ramp levels to be no lower than 0.5m above the 100 year ARI flood level. Where below ground car parking is proposed additional measures must achieve protection up to the PMF.	No garages or enclosed parking is proposed as part of this development.
5	Unless otherwise approved by Council and provided this does not obstruct or displace floodwaters, the level of the driveway providing access between the road and parking spaces shall be no lower than 0.2 metres below the 1% AEP (100 year ARI) flood level.	The driveway provides rising egress from the site above the 1% AEP level.
6	Enclosed car parking, and car parking areas accommodating more than 3 motor vehicles, with a floor below the 1% AEP (100	No enclosed parking is proposed as part of this development.

Reference	Control	GRC Comment
	year ARI) flood level, shall have adequate warning systems, signage, exits and evacuation routes. Refer to Flood Warning and emergency Response Planning section of the Parramatta DCP for requirements.	
7	Restraints or vehicle barriers to be provided to prevent floating vehicles leaving a site during a 1% AEP (100 year ARI flood.)	As the car park is not flood liable in the 1% AEP event no use of barriers is proposed.
Evacuation		
3	Reliable access for pedestrians required from the site to an area of refuge (including shelter in place) above the PMF level, on site (e.g. second storey) or off site.	Provision has been made to allow pedestrians to travel up to the first level (elevated at 13.35 mAHD, higher than the PMF level of 10.4 mAHD) and safely congregate there as part of a shelter-in-place strategy. Back up electricity and water provision will be included in the event of an emergency.
4	Applicant is to demonstrate the development is consistent with any relevant flood emergency response plan, flood risk management plan or similar plan.	A flood emergency response plan has been developed and documented in this report above which encourages early evacuation based on BoM warnings and also makes clear that the SES is the combat agency and their evacuation orders are to be deferred to in the event of an emergency as per the Parramatta EMPLAN.
6	Adequate flood warning is to be available to allow safe and orderly evacuation without increased reliance upon SES or other authorised emergency services personnel.	The proposed development will include a flood warning system to alert occupants when to evacuate or shelter in place on Level 1.
Management and Design		
2	Flood emergency response plan required where the site is affected by the 1% AEP (100 year ARI) flood level. Plan is to detail procedures that would be in place for an emergency (such as warning systems, signage and evacuation emergency drills) and should consider the following aspects: (i) preparing for a flood, (ii) responding when a flood is likely, (iii) responding during a flood, and (iv) recovery after a flood. Must be consistent with Flood Warning and Emergency Response Planning requirements outlined in DCP.	This plan has been outlined previously in this report. See Section 7.
3	Applicant is to demonstrate that sufficient area is available to store goods above the	The building's ground floor is proposed above the 1% AEP (100 year ARI) flood level plus 0.5

Reference	Control	GRC Comment
	1% AEP (100 year ARI) flood level plus 0.5 metre freeboard.	metre freeboard. Therefore all storage space will be above this level.
4	No storage of materials below the Flood Planning Level (1% AEP flood plus 0.5 metre freeboard) which may cause pollution or be potentially hazardous during any flood.	The building's ground floor is proposed above the 1% AEP (100 year ARI) flood level plus 0.5 metre freeboard. Therefore all storage space will be above this level.

8.1.2 Parramatta Local Environmental Plan (2023)

The proposed development aligns with the flood-related controls in the LEP as outlined in the table below.

Table 10: Flood-Related LEP Controls Relevant to the Proposed Development

Reference	Control	GRC Comment
	Parramatta LEP 2023 – 7.11	
(3)	Development consent must not be granted to the erection of a building on the land unless the consent authority is satisfied the building— (a) contains an area that is— (i) located above the probable maximum flood level, and (ii) connected to an emergency electricity and water supply, and (iii) of sufficient size to provide refuge for all occupants of the building, including residents, workers and visitors, and (b) has an emergency access point to land above the 1% annual exceedance probability event, and (c) is able to withstand the forces of floodwaters, debris and buoyancy resulting from a probable maximum flood event.	An emergency access point connecting the building above the 1% and 0.2% AEP flood levels is located near to the south-western entrance of the proposed development. The proposed design includes provision to be connected to an emergency electricity and water supply and has sufficient space on level 1 and above to allow all occupants of the building to safely shelter above the PMF level (10.3 mAHD) in the event of an emergency. There are three publicly accessible levels proposed above the PMF level so ample space will be available to allow all occupants to comfortably shelter in place. Separate to this report, structural integrity under PMF flood forces is confirmed by TTW. The probability of a simultaneous PMF and vehicle-debris impact is extremely low (See Figure 70); therefore, designing the building to withstand both events occurring together is

Reference	Control	GRC Comment
		considered incongruous with the building design life and frankly with risk management practices broadly.
(4)	Subclause (3)(a) does not apply if— (a) there is pedestrian access located between the building and land above the probable maximum flood level, and (b) the pedestrian access is located above the probable maximum flood level.	Subclause (3)(a) does apply.

8.2 Addressing Government Guidance

In the course of developing this flood impact risk assessment, GRC has done so according to the following guidelines:

- Shelter-in-Place Guidelines for Flash Flooding;
- Understanding and Managing Flood Risk (FB01); and
- Support for Emergency Management Planning (EM01)

8.2.1 Shelter-in-Place Guidelines for Flash Flooding

The NSW Department of Planning, Housing and Infrastructure finalised its updated *Shelter-in-Place Guidelines for Flash Flooding* in January of 2025. This document provides guidance for developments in flood-prone areas to ensure the safety of occupants during flash flood events. Below is a summary of the key criteria that a proposed development or site must meet to satisfy the guidelines for sheltering in place during a flood event:

1. does shelter-in-place align with existing emergency management strategies for the area, as determined through the flood risk management process and by the NSW SES.

   GRC has developed a flood emergency response plan (FERP) that seeks to adopt and respond to elements of the NSW State Emergency Management Plan (EMPLAN) and the Sydney Metropolitan Region Emergency Management Plan.

   Early evacuation has been adopted as the primary strategy but Shelter-in-Place has been retained as a back-up strategy in case some occupants find themselves at the site when a flash flooding event does occur.

   Shelter in Place strategies have been used for developments throughout the City of Parramatta LGA. GRC Hydro believes that shelter-in-place is a good back-up strategy in the event of flash flooding at this site for the following reasons:

   - this site can be subject to flash flooding, a phenomenon where flooding can occur with little warning for on-site occupants;

- once flash flooding has begun, surrounding roads throughout Rydalmere and Parramatta (a large affected area) can become inundated and unsafe for evacuees in cars and on foot; and
- during a flash flooding event, evacuees are unlikely to be aware which road routes might be safe for them to use throughout the broader flood-affected area.

2. has evacuation off-site (the primary emergency management strategy) been investigated and determined to be unachievable

   Early Evacuation has been investigated and adopted as the primary emergency response strategy. The trigger is a Severe Weather Warning (Rain) for Sydney or a Severe Thunderstorm Warning and the estimated daily rainfall exceeding 100 mm. These are conservative warning triggers that can offer advanced warning based on BoM forecasts. Shelter-in-place has been retained as a back-up strategy in case some people are present after evacuation been directed and if flash flooding occurs at that time.

3. does the development include medical centres, emergency service and community facilities, and sensitive and hazardous land uses, some of which may not be suitable for shelter-in-place.
   No. The site does not include medical centres, emergency service and community facilities, and sensitive and hazardous land uses. The site will be predominantly occupied by adults (students and faculty staff) ranging in age from 17 to 65. Refuge space above the PMF level will be readily accessible to any occupants with mobility restrictions.

4. shelter-in-place for greenfield development is not supported
   The site is not greenfield. The development is situated on a currently operating university campus with the demolition of an existing car park required to facilitate its construction.

5. whether there is existing government developed flood warning systems that give advanced detailed forecasts of flash flooding to allow sufficient time to evacuate to the proposed refuge locations
   There is a government-developed flood warning system: the City of Parramatta's FloodSmart system, however it may not allow sufficient time to evacuate this site given it can be affected by flash flooding.

6. can the community effectively be informed of the risks associated with the emergency management strategy

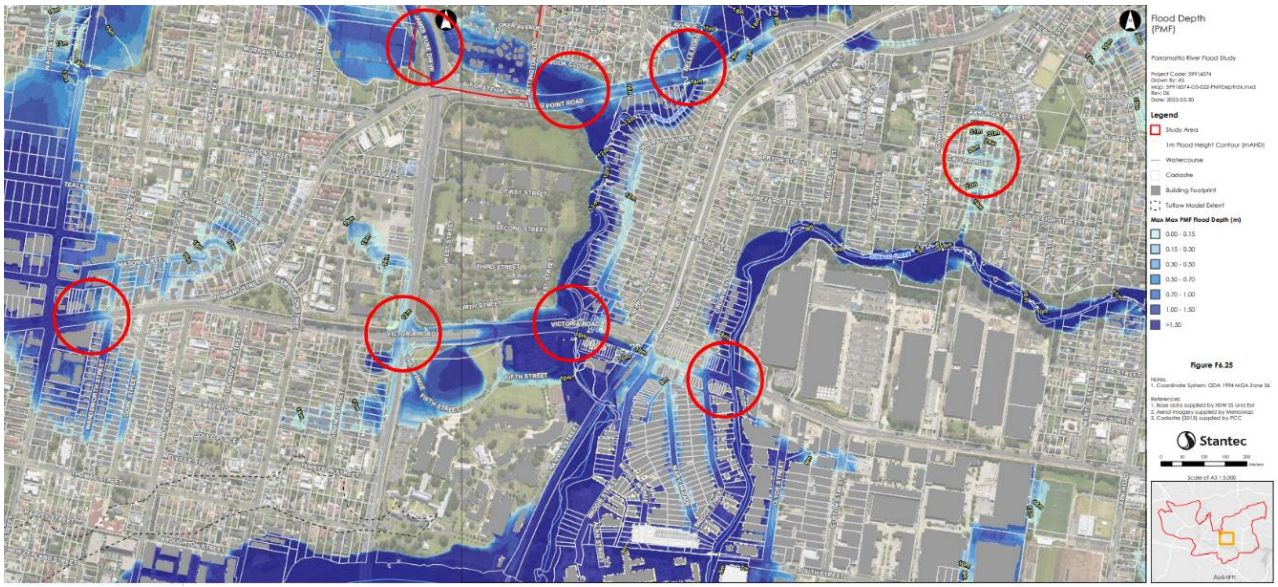
   Yes, the existing operations at the site have an emergency management strategy that is communicated digitally (website, email and text), verbally and via signage. This has engendered an institution-wide awareness of potential hazards at the site and the emergency management strategies to address them.

Following satisfactory consideration of the above issues, the Flood Impact and Risk Assessment (FIRA) being undertaken for the site must provide advice for the consent authority to consider the suitability of the site for shelter-in-place. The FIRA should include:

7. detailed assessment of evacuation off-site (the primary emergency management strategy) to determine that evacuation off-site is not achievable.
   A detailed assessment of potential evacuation routes has been included in this FIRA. This assessment demonstrates that many potential flood obstacles exist away from the site that could pose a risk to occupants attempting to evacuate during a flash-flooding event. This is why very early

evacuation – triggered by advanced BoM Severe Weather Warnings (Rain) for Sydney and the estimated daily rainfall exceeding 100 mm have been adopted as a conservative primary option instead of waiting for a local flood trigger. The locations of these obstacles are identified below.

Figure 69: Road Network Inundation Locations in a PMF Event



8. the flood behaviour at the site, with consideration of climate change and assessment of the potential maximum duration of isolation up to and including the PMF to identify that:
    a. flash flooding is the only flood risk present at the site, whether it be from overland flooding, local creek or riverine flooding, and

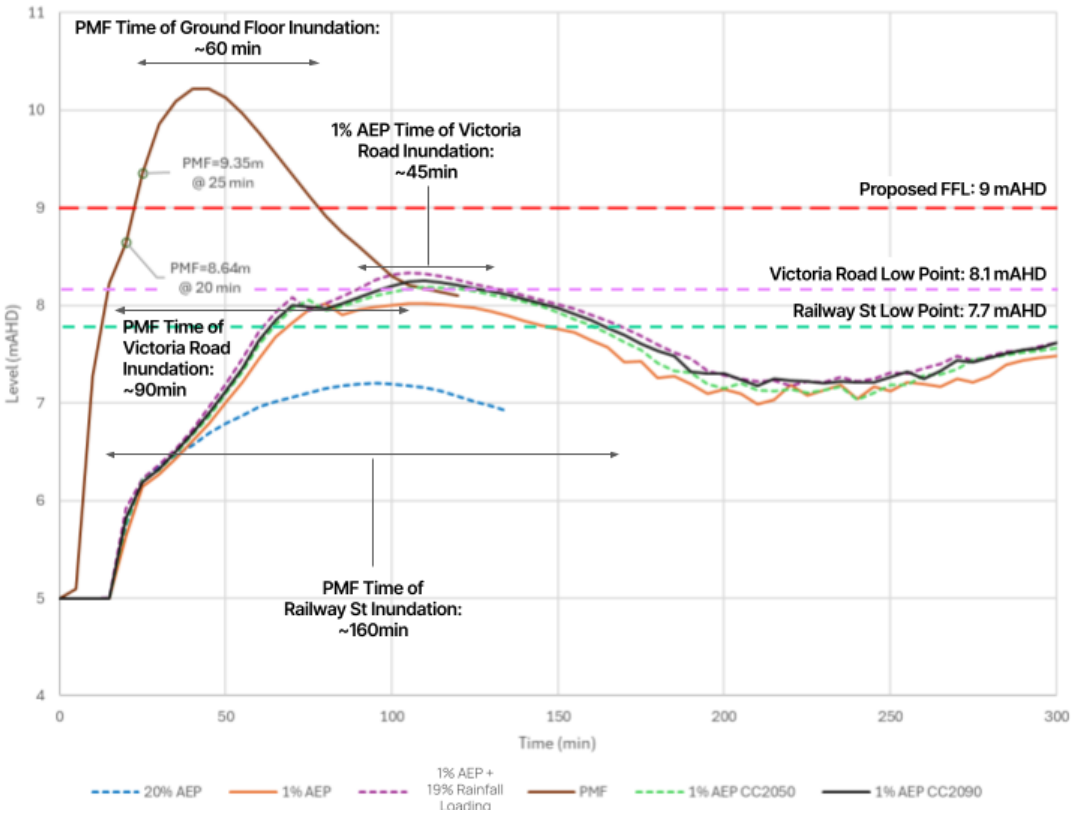
    The site is subject to three mechanisms:

    - Overland flash flooding coming from the west of the site. This is only minor.
    - Mainstream flash flooding that overtops Vineyard Creek upstream of Victoria Road and then flows into the site from the north-east; and
    - In a PMF event only, the Parramatta River level reaches the proposed ground floor level of 9.0 mAHD. In more common events, the flood affectation at the site exhibits no sensitivity to Parramatta River levels.

    b. the flooding occurs within less than 6 hours from the commencement of causative rain and the duration of shelter-in-place due to isolation by floodwaters is less than 12 hours from the commencement of rainfall, and

    The modelled local inundation at the site and at the Victoria Road crossing above Vineyard Creek is documented in the hydrograph below. In all events, the modelling suggests that the site's isolation will have ended within 2 and a half hours following the commencement of rainfall.

Chart 3: Hydrograph of Inundation at Site (Downstream of Victoria Road Culvert)



c. the development is not subject to high hazard flooding (e.g. floodways, high hazard H5 or H6 areas) or surrounding roadways are not subject to high hazard flooding.
The site is not subject to a floodway. In the 1% AEP event, the site is subject to a maximum hazard of H3. H5 doesn't start to impact the proposed development until the extremely rare PMF event. A PMF event has an approximate likelihood of 1 in 1,000,000 years (*Nathan, R., Hill, P., & Weinmann, E. (2011). Achieving consistency in derivation of the Probable Maximum Flood. Proceedings ANCOLD Conf on Dams. Melbourne, Australia*).

Following consideration of items 1 to 7, and if items 8a, b and c are met, and the consent authority considers shelter-in-place is an appropriate emergency response strategy the following items must also be considered through a FIRA:

9. how shelter-in-place will be:
    a. used as part of the site's emergency management response, including actions before, during and after sheltering-in-place, and

    Shelter in Place is to be used as the back-up emergency strategy in case some occupants remain at the site after an early evacuation Act Now direction. Occupants will be given approval to safely leave the site once flooding recedes back to the 5% AEP flood event and clearance is sought from the local SES. This is explained in more detail in the FERP procedures.

    b. communicated to occupants and visitors of the building and how this communication will be maintained for the life of the development.

In ordinary times, occupants will be made aware of the site's flood liability and evacuation procedure via posters shown throughout the campus and communicated to new students and staff as a part of an induction process. This will remain a fundamental part of the campus's introduction of the site to new students, faculty and guests.

As per WSU's existing procedures, when large storms are predicted, staff and students will be sent a text or email to encourage them leave or stay away from the site (early evacuation).

As an event occurs, alerts (sirens and PA instructions), information posters, evacuation/shelter mapping will all be used to communicate the procedure by which safe shelter should be sought in an emergency.

10. an understanding of the secondary risks and how the proponent proposes they will be managed is outlined in the FIRA. Secondary risks include medical emergencies, building fire, health and wellbeing.

    During secondary emergencies, the site can be reached via the southern entrance in a 0.2% AEP event. Even when Victoria Rd is inundated, occupants can evacuate overland to other parts of the campus which can offer shelter and are higher than the PMF. In a PMF event, stranded sheltering occupants will likely only be isolated from emergency services for 60 minutes or less.

The consent authority should reflect the following design criteria (I to III) in relevant conditions of consent:

I. the floor level of the shelter-in-place part of the development be above the PMF, and

   The shelter-in-place area on levels one and above is higher than the PMF level

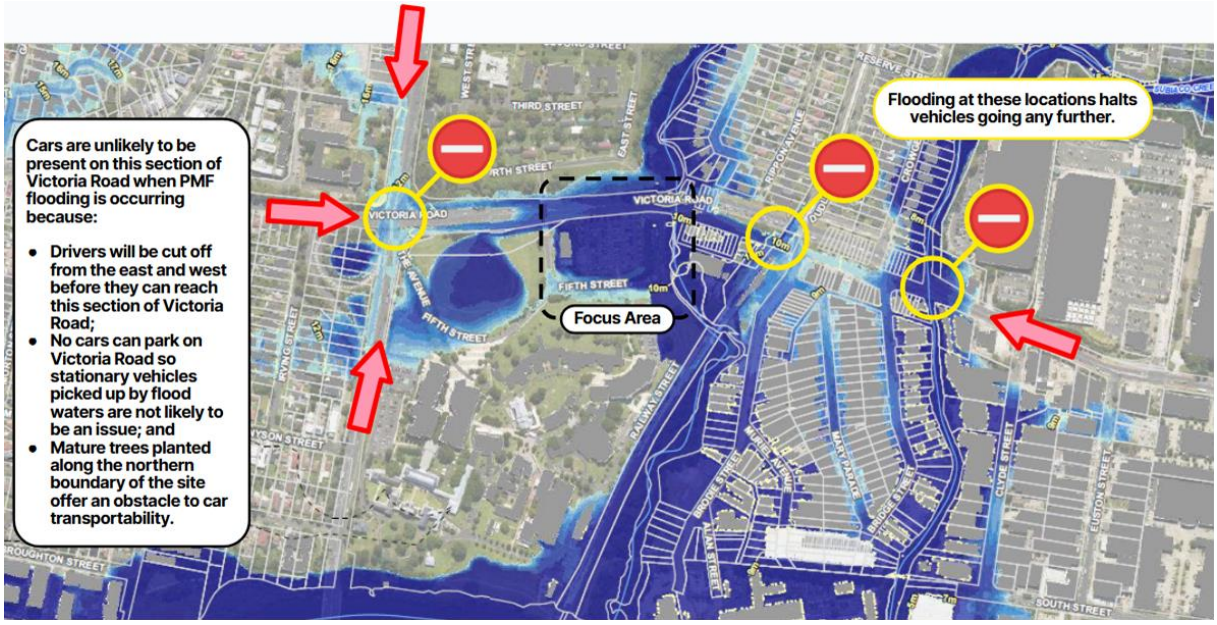
II. structural soundness for conditions in a PMF event, considering flood and debris forces, be verified by a suitably qualified structural engineer, and

    Structural soundness in a PMF event (due to flow alone) is attested to in TTW's letter (reference 234338 SAAA).

    CPHR comment that the proposed works should be designed such that, given a debris strike during a PMF event, structural soundness is assured.

    GRC have reviewed the plausibility of heavy debris such as a vehicle striking the proposed works. See the attached map with notes regarding the availability of suitable debris sources (vehicles mainly). Due to inundation of roads leading to the site and the lack of parking areas subject to floodway flows upstream of the site, the likelihood of such an occurrence appears plausibly low.

Figure 70: Assessment of the Extremely Low Probability of Vehicle Impact on the Building



DPHI do advocate a risk-based approach for development in NSW. This does not imply the expunging of all risk. Joint probability tells us that the chance of a vehicle strike occurring simultaneously with a PMF is lower than the probability of a PMF alone. The PMF itself of course is the largest event that can occur at the site, and the probability is estimated to be on the order of one in one million years.

On the face of it, constructing the building such that it is unimpacted by a PMF event combined with a significant debris strike, seems incongruous with the building design life and frankly with risk management practices broadly.

III. area and access to the area does not rely on access to electricity, is self-directing, and have clearly marked internal access for all people on site, including consideration of access for potential occupants and/or visitors.

The area and access to the area will not rely on access to electricity (accessible via stairs and no accreditation or security keys will be required to access this publicly accessible area) and will be clearly marked and accessible to all occupants or visitors. Backup power will also be provided – the details of which can be provided as a condition of consent.

The consent authority may also consider the following design criteria (IV to X) when setting relevant conditions of consent depending on the scale and type of development: IV. protection from weather and appropriate heating and cooling

IV. access to personal hygiene facilities such as a toilet
Toilets are located on level one and above.

V. a minimum floor space of 2 m^2 per person.
The proposed building is a campus with ample public space. The building has been designed to be spacious during everyday use – more so than a regular commercial building – and this space will be more pronounced in an emergency situation where the number of occupants is much lower than

normal as the result of filtering process that includes dissuading occupants to come to the facility in the first place. If the need to place was triggered during the site's busiest period, it could safely sustain 8.6 m^2 per person.

VI. items for self-sufficiency that are stored, maintained and are regularly updated in an accessible location above the PMF, including sufficient drinking water and food for occupants, fire extinguishers, radios and torches with spare batteries, and a first aid kit with an automated external defibrillator (AED)
A checklist of these items has been mandated and outlined in the FERP in this report.

VII. centralised communal shelters may be considered but must be freely accessible internally at all times and externally accessible during events
The proposed shelter areas are freely accessible internally at all times. Sheltering occupants will be able to access external areas with fresh air situated well above the PMF level.

VIII. access is provided to onsite systems that generate power of the shelter-in-place location during and after the event for a full range of flood events up to the PMF. Detail how these requirements will be maintained and enforced for the life of the development.
Backup power and water supply will be provided via the use of a mixture of batteries, generators and tanks, all elevated on level one or above. Further details specific to these backup systems will be provided during the detailed design phase.

8.2.2 Flood Risk Management: Understanding Flood Behaviour (FB01)

GRC has reviewed DPHI's "Understanding and Managing Flood Risk- Flood Risk Management Guideline FB01" in the course of developing this flood assessment and response plan. Whilst this guideline doesn't stipulate a range of specific, defined criteria for developments, GRC has addressed the how the proposed development and this FIRA has addressed the general topics discussed in this guideline below.

Understanding Flood Behaviour

- The development must assess the flood behaviour of the area, including flood sources, pathways, and potential impacts.
- **GRC Response**: GRC has assessed the flood behaviour of the site for a variety of design storm events, in both the existing and proposed condition, and have modelled the potential flood level impacts.

Flood Risk Assessment

- A detailed flood risk assessment must be conducted to evaluate the likelihood and consequences of flooding, including the potential for property damage, loss of life, and environmental harm.
- **GRC Response**: GRC has undertaken a risk assessment for the site and proposed development and this is included in this report.

Flood Planning Levels (FPLs)

- The development must comply with designated Flood Planning Levels (FPLs), which define the height and extent of flooding that the development must be designed to withstand.
- **GRC Response**: GRC has adopted the Parramatta DCP's (2023) Flood Planning Level criteria of the 1% AEP flood level + 0.5 m freeboard. The proposed development's compliance with the DCP defined FPL is demonstrated in Section 8.1.1.

Design and Construction Standards

- The development must adhere to design and construction standards that mitigate flood risks, such as elevating structures, using flood-resistant materials, and incorporating flood-compatible land uses.
- **GRC Response**: The proposed development will be constructed using flood-safe materials and methods. This will be verified in separate reporting by structural engineers associated with the project. (reference TTW 234338 SAAA)

Emergency Response Planning

- The development must include an emergency response plan that addresses evacuation routes, flood warnings, and community preparedness.
- **GRC Response**: GRC has developed a Flood Emergency Response Plan (FERP) in Section 7. This FERP addresses evacuation routes, flood warnings, and community preparedness.

Environmental Considerations

- The development must consider the environmental impacts of flooding, including the potential for erosion, sedimentation, and damage to ecosystems.
- **GRC Response**: The site is an existing hard-stand car park. The proposed development will introduce native landscape and ephemeral watercourse features. The site is disconnected from the Vineyard Creek riparian corridor so there is very little potential for the proposed development to contribute to erosion, sedimentation and damage to ecosystems.

Community and Stakeholder Engagement

- The development must involve community and stakeholder engagement to ensure that flood risks are understood and that the proposed measures are socially acceptable.
- **GRC Response**: WSU will engage with its student cohort, faculty and any other relevant stakeholders to build upon and strengthen the development's FERP.

Compliance with Local and State Regulations

- The development must comply with all relevant local and state regulations, including floodplain management plans and development controls.
- **GRC Response**: Compliance with the intent and controls of the local LEP, DCP and state guidance has been demonstrated in Section 8.

Climate Change Considerations

- The development must account for the potential impacts of climate change, such as increased rainfall intensity and sea level rise, on flood risk.
- GRC Response: The potential impacts of climate change have been incorporated into GRCs modelling. Potential climate change scenarios have been modelled in GRC's flood impact risk assessment.

Monitoring and Maintenance

- The development must include plans for ongoing monitoring and maintenance of flood mitigation measures to ensure their effectiveness over time.
- GRC Response: Ongoing monitoring and maintenance of flood risk management measures is incorporated in the FERP guidance.

8.2.3 Support for Emergency Management Planning Support (EM01)

GRC has reviewed DPHI's "*Support for Emergency Management Planning*" (EM01) in the course of developing this flood assessment and response plan. Whilst this guideline doesn't stipulate a range of specific, defined criteria for developments, GRC has addressed the how the proposed development and this FIRA has addressed the general topics discussed in this guideline below.

Flood Risk Assessment and Mapping

- Criteria: The development must be based on a comprehensive flood risk assessment, including flood mapping that identifies flood extents, depths, velocities, and hazards.
- GRC Response: This flood impact risk assessment has involved the modelling of a variety of design flood events and the result of this has been a suite of mapping that documents flood extents, depths, velocities, and hazards at the site in both the existing and proposed scenarios.

Emergency Response Planning

- Criteria: The development must include a robust emergency response plan that addresses evacuation routes, flood warnings, and community preparedness.
- GRC Response: The FERP component of this report addresses evacuation routes, flood warnings, and community preparedness.

Flood Warning Systems

- Criteria: The development must incorporate or align with existing flood warning systems to ensure timely and accurate information is available to residents and emergency services.
- GRC Response: The FERP component of this report discusses that the site lies within an area that has a broad flood warning system called FloodSmart and observance and response to FloodSmart is incorporated into the flood emergency response plan. FloodSmart warnings will be communicated to all potential on-site stakeholders with additional directions specific to the site.

Community Engagement and Education

- **Criteria**: The development should involve community engagement and education programs to ensure residents understand flood risks and know how to respond during a flood event.
- **GRC Response**: WSU will engage with its student cohort, faculty and any other relevant stakeholders to build upon and strengthen the development's FERP.

Flood-Compatible Design and Construction

- **Criteria**: The development must adhere to flood-compatible design and construction standards, such as elevating structures, using flood-resistant materials, and avoiding high-risk areas.
- **GRC Response**: All DCP and LEP criteria have been met as is documented herein.

Evacuation Planning

- **Criteria**: The development must include clear and safe evacuation routes and plans, ensuring that residents can evacuate quickly and safely during a flood.
- **GRC Response**: Evacuation planning has been documented in the FERP above. Early evacuation has been adopted as the primary response with a conservative trigger based on forecasting. This is designed to vacate the site well in advance of a storm event occurring so that occupants can use their ordinary route home.

Integration with Local and Regional Plans

- **Criteria**: The development must align with local and regional floodplain management plans, emergency management plans, and other relevant strategies.
- **GRC Response**: The proposed development's FERP has been developed so as to align with state and Sydney metropolitan EMPLANS.

Resilience and Adaptation Measures

- **Criteria**: The development must incorporate resilience and adaptation measures to address future flood risks, including those exacerbated by climate change.
- **GRC Response**: The proposed design is to be constructed using flood resilient materials and its ground flood finished floor level is elevated well above the 1% AEP flood level.

Monitoring and Maintenance of Flood Mitigation Measures

- **Criteria**: The development must include plans for ongoing monitoring and maintenance of flood mitigation measures to ensure their long-term effectiveness.
- **GRC Response**: The FERP detailed in Section 7 includes feedback loops to improve flood risk management as time passes. There are no mitigation measures that require maintenance (for example operated flood gate).

Compliance with Regulatory Requirements

- Criteria: The development must comply with all relevant local, state, and national regulations, including floodplain development controls and emergency management standards.
- GRC Response: Compliance with the intent and controls of the local LEP, DCP and state guidance has been demonstrated in Section 8.

8.2.4 Addressing the goals of the NSW State Flood Plan

The proposed development, the design that's been adapted in order to address flooding issues and its approach to flood emergency response is in alignment with the goals outlined in the NSW State Flood Plan.

The goals for flood emergency management in NSW are to:

- Protect and preserve life.

  Response: The building has been designed with flood resilience in mind. A conservative early evacuation strategy allows all occupants to leave the affected area well in advance of a storm event and the back-up shelter-in-place strategy allows any remaining occupants to rise well above the PMF level and seek safe shelter in a structurally sound building for the short amount of time (less than 1 hour) that the site can be flood affected.

- Promote protective behaviours in the community by building flood resilience of communities through awareness campaigns and community outreach.

  Response: WSU has an existing strategy to promote protective behaviours in its community (staff, students and guests). This is exhibited through very public awareness campaigns delivered throughout the campus via posters, emails, announcements and texts. WSU currently alerts staff and students to stay home from the Parramatta South campus.

- Protect property including critical infrastructure, community assets and residential property.

  Response: This proposed community asset has been designed in response to the flood affectation at the site. The levels have been designed accordingly (with 0.5 m freeboard on top of the 1% AEP flood level) as has the structure of the building with regard to potential flood forces.

- Enhance the community's capability to make safer decisions by implementing effective warning systems and enabling accurate and timely two-way communications between agencies and communities.

  Response: An automated sump-alarm warning system has been implemented in the updated FERP. WSU flood wardens will liaise with the SES when flood alerts are triggered and initiate a two-way communication channel between WSU and the SES.

- Provide clarity of the command, control and coordination of effective flood focused activities across the prevention, preparation, response and early recovery stages.

  Response: This has been outlined in the updated FERP.

- Protect the natural environment and conservation values, including cultural heritage, biodiversity and social values.

  Response: The proposed development has integrated culturally and environmentally sensitive landscape to pay homage to the pre-European land use and reintroduce environmental diversity to a site currently occupied by an asphalt carpark.

- Value and respect Aboriginal and Torres Strait Islander cultures, lands, waterways and people.

  Response: The proposed development has been led by local indigenous feedback and the development's raison d'être is to champion indigenous culture. The site's landscaping design has been informed by a waterway that was present at the site prior to European settlement.

- Consider the safety and well-being of the emergency service members and the broader community, with a focus on the social impacts of flooding.

  Response: Adopting a shelter-in-place emergency response approach considers the safety and well-being of the emergency service members and the broader community by making sure the community and SES members aren't unnecessarily exposed to dangerous floodwaters during flash flooding. This keeps occupants safe and keeps them out of floodwaters and off the roads as floodwaters are flowing through.

- Promote community-centred recovery.

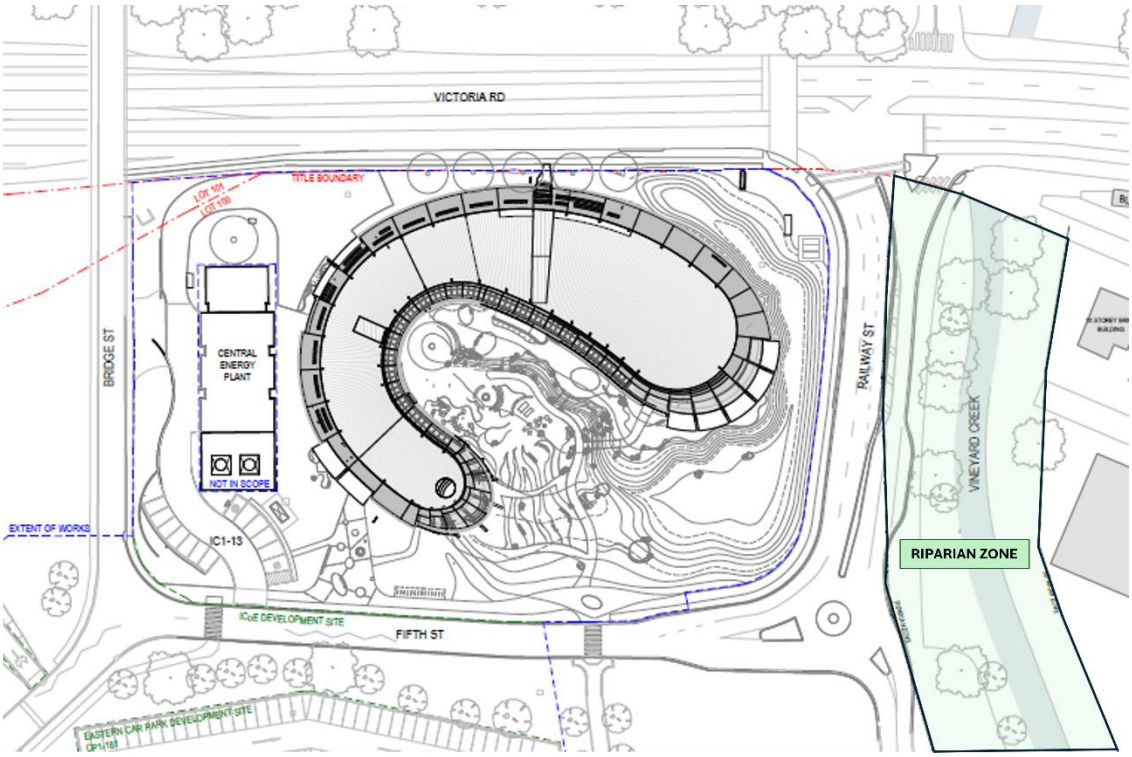
  Response: Adopting a shelter-in-place emergency response approach allows WSU to take control of the site's flood response without adding further burden to flood response activities that may be occurring throughout the rest of the local community.

9 Riparian Zone Management Assessment

NSW Government guidelines set out objectives for development in the vicinity of a creek or other watercourse. The guidance is presented in the NSW Department of Planning and Environment Fact Sheet "Controlled Activities – Guidelines for Riparian Corridors on Waterfront Land" (2022) and is based on the relevant legislation (Water Management Act 2000).

The subject site is approximately 40 m west of Vineyard Creek. The riparian corridor of the creek is defined as the channel itself including its banks, plus the Vegetated Riparian Zone (VRZ) on either side of the channel. The VRZ is of constant width and is based on the channel's Strahler Stream Order. NSW GIS data available online on the 'NSW Map' website indicates a Strahler Stream Order of 2. This does not encroach on the site. Note that typically a creek with a catchment area of several square kilometres might be expected to be Strahler 4 at the campus and the discrepancy may pertain to upstream tributaries having been piped. In any case, as is described below, outside of the current creek bank, existing levels of development are significant and not proposed to be altered at this time.

Figure 71: Riparian Corridor



The creek in the vicinity of the site consists of a narrow channel of around 3-5 m width, with sloped banks on either side occupying a total width of ~20m. In this corridor the creek has been fully disturbed from its natural state, and now has a mix of cleared areas, native and non-native vegetation. Examples are shown in Image 5 below. Outside of this corridor on the western side of the creek (i.e. towards the subject site) there are no remnants of the original riparian vegetated zone, and is now a mix of fences, grass, bitumen roads, concrete footpath and trees adjacent to the car park that were planted in approximately 2011.

Image 5: Riparian Investigation Photos





Once the RVZ is identified and mapped, the guideline requires that development:

- maintain or rehabilitate a RC/VRZ with fully structured native vegetation in accordance with Table 1 Controlled activities – Guidelines for riparian corridors on waterfront land Department of Planning and Environment 4
- minimise disturbance and harm to the recommended RC/VRZ
- minimise the number of creek crossings and provide perimeter road separating development from the RC/VRZ
- locate services and infrastructure outside of the RC/VRZ. Within the RC/VRZ provide multiple service easements and/or utilise road crossings where possible
- treat stormwater run-off before discharging into the RC/VRZ.

Given the location of the subject site in what is currently a sealed car park, and no creek crossings are proposed, it is recommended to incorporate the following measures in the design and construction of the proposed building:

1. Minimise disturbance and harm to the area via use of a sediment control and erosion plan, for the construction phase of the project.
2. Include stormwater treatment in the design of the site's drainage

10 Summary

The proposed development has been designed in be compatible with the existing flood regime at the subject site. Key features are:

- Elevated FFL at 9.0 mAHD versus 1% AEP (Present-Day Climate Change) level of 8.49 mAHD;
- Building to be constructed on slab;
- Landscaping sympathetic to inflow and avoiding filling of subject site;
- Means of egress to flood free areas external to the building in 1% AEP (Present-Day Climate Change);
- Deference to the SES as the combat agency in an emergency and the adoption of a simple and uncomplicated shelter-in-place approach in the event of flash flooding at the site; and
- Facilitation of shelter in place (at 13.35 mAHD or above) for the worst possible flood, the PMF event (10.3 mAHD), which has a potential isolation period of less than 1 hour.

The impact of this development on flood affectation at the site has been modelled and any adverse flood level impacts predicted as a result of this development are contained within the site.

In addition to a Flood Impact Assessment, this report contains a Flood Emergency Response Plan for the proposed development and a Riparian Zone Management Assessment.

The proposed development has been assessed relative to its flood affectation and the flood-related controls outlined in the Parramatta LEP and DCP and have been found to be compliant with these controls.

Appendix A: Council Flood Certificate

Our Reference: FL/205/2023
Contact: Peter Sirianni
Telephone: 02 9806 8250
Fax: 02 9806 5906

GRC Hydro
Level 20/66 Goulburn St
SYDNEY NSW 2000

12 October 2023

FLOOD ENQUIRY APPLICATION

Property Details

Address	171 Victoria Road, PARRAMATTA NSW 2150
	This form applies for up to three adjoining sites relating to the same development. A separate Flood Enquiry form and fee will be required for more than 3 or separate lots.

Delivery Preference

matthew@grchydro.com.au

Reason for Enquiry

Property Type

***** GST not applicable from 1 July 2013*****

Flooding Application – Commercial	$599.00

Disclaimer: Flood levels and flood extent lines are based on current information held by Council. Council does not accept responsibility for the accuracy of this information. Any pipe sizes and location of pits and pipe lines should be confirmed by site investigation.
The flood levels shown on the back of this form are only an approximate guide and have been derived using the current computer simulated model.
The information provided in this document is presented in good faith to assist the public in understanding Council's drainage requirements that apply within the Parramatta Local Government Area. It is the responsibility of each individual using this information to undertake their own checks and confirm this information prior to its use.
City of Parramatta Council, its agents and employees are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement, or advice referred to above.

Refer to back of this form for level information issued

Flood Enquiry Information Issued - 12 October 2023

Mainstream Flooding

Is this property affected by mainstream flooding? **171 Victoria Road, PARRAMATTA**		☒ Yes ☐ No
Flood Levels	Closest Cross Sections: *(Please refer to Flood Study)*: **Refer to Flood Map**	
5% AEP	Refer to Flood Map	**Comments**: **See Note on Flood/Hazard Map**
1% AEP		
PMF		
☒ Refer to flood maps provided for detailed flood levels.		
Flood information is obtained from the following flood study report: 1. **Lower Parramatta River Floodplain Risk Management Study – Flood Study Review, 2005 (SKM)** 2. **Vineyard Creek Sub-Catchment Management Plan, 2004 (SMEC)**		

Note: Flood inundation can be verified by detail survey to AHD undertaken by a Registered Surveyor.

Local Flooding

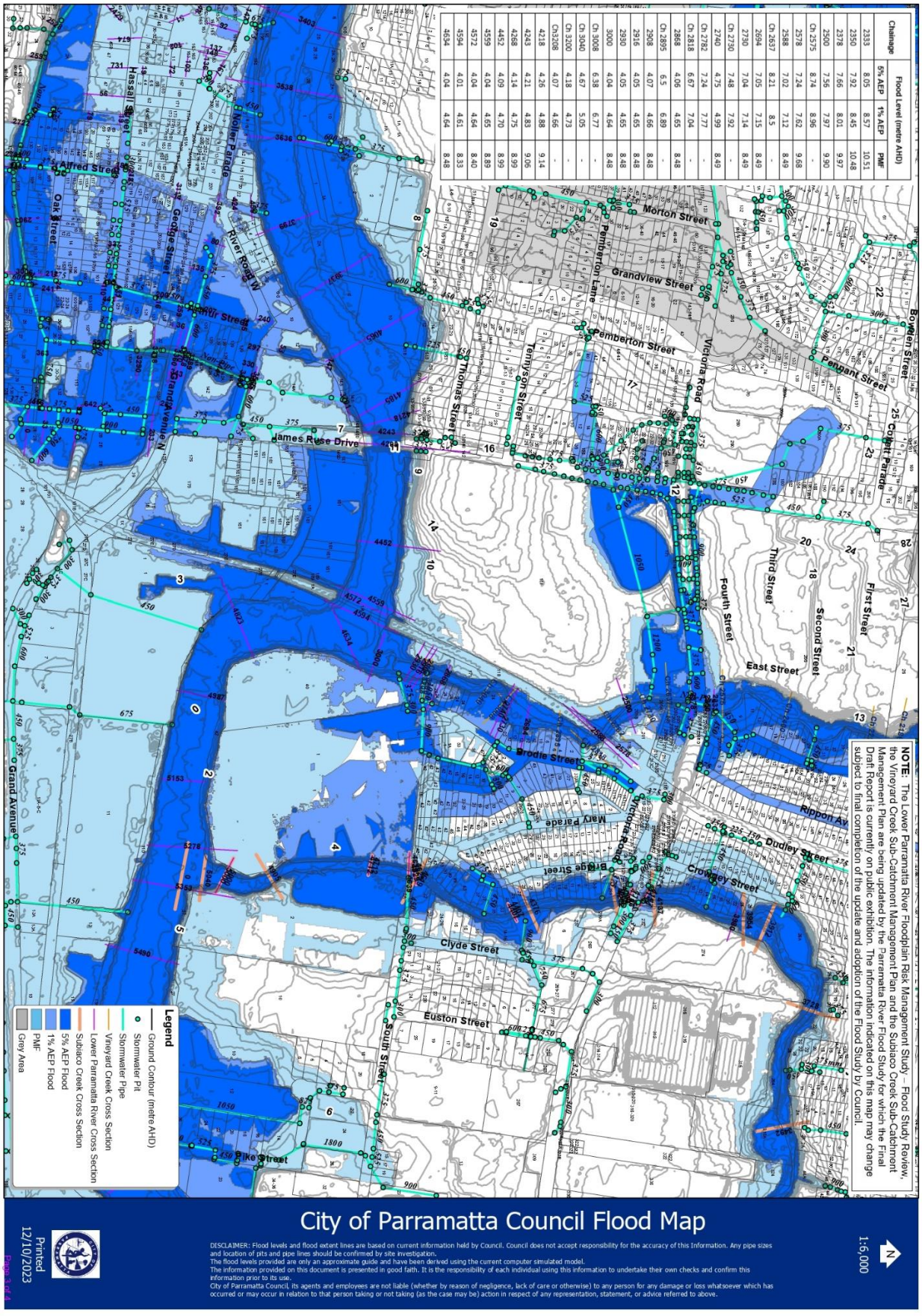
Is the property located within a Hatched Grey Area? *Properties located within a **Hatched Grey Area** are subjected to flooding from the local catchment.*	☐ Yes ☒ No
Is the property located within a Grey Area? *Properties located within a **Grey Area** are subjected to additional site drainage controls to manage flooding in the local catchment.*	☐ Yes ☒ No
Is the property likely to be affected by overland stormwater run-off from the local catchment?	☒ Subject to Detailed Investigation
***Note**: You are required to contact Council's Development Service Engineer for any details and requirements relating to development that is affected by local flooding.*	

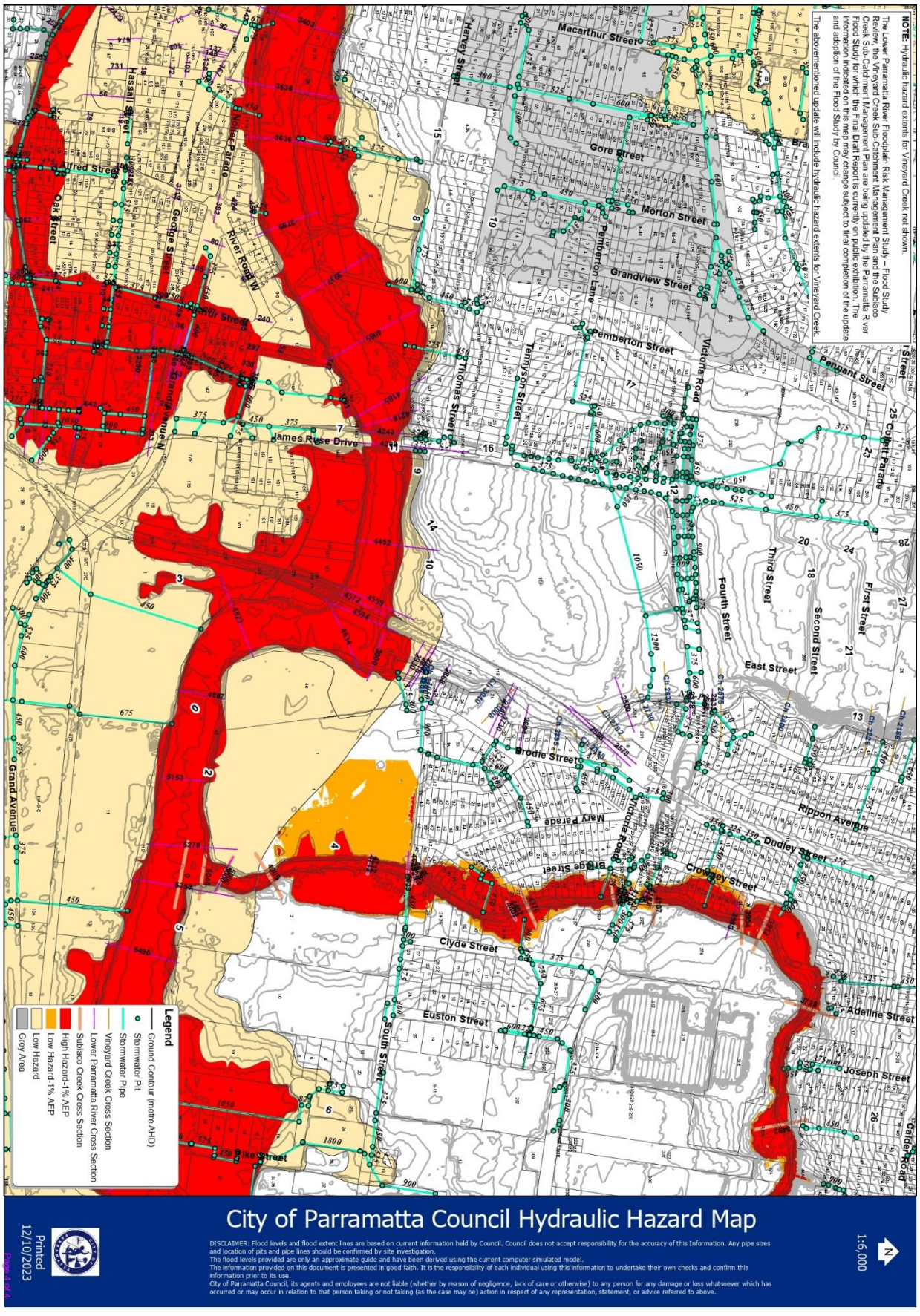
Additional Recommended Actions

☒	The Applicant needs to discuss the proposal to re-develop this site with Council's Town Planner and Development Services Engineer.
☒	The Applicant needs to contact Council's Town Planner and organise a pre-lodgement meeting to discuss any proposal to redevelop this property.
☒	The Applicant needs to refer to Council's Local Floodplain Risk Management policy for details relating to developing a land affected by flooding.

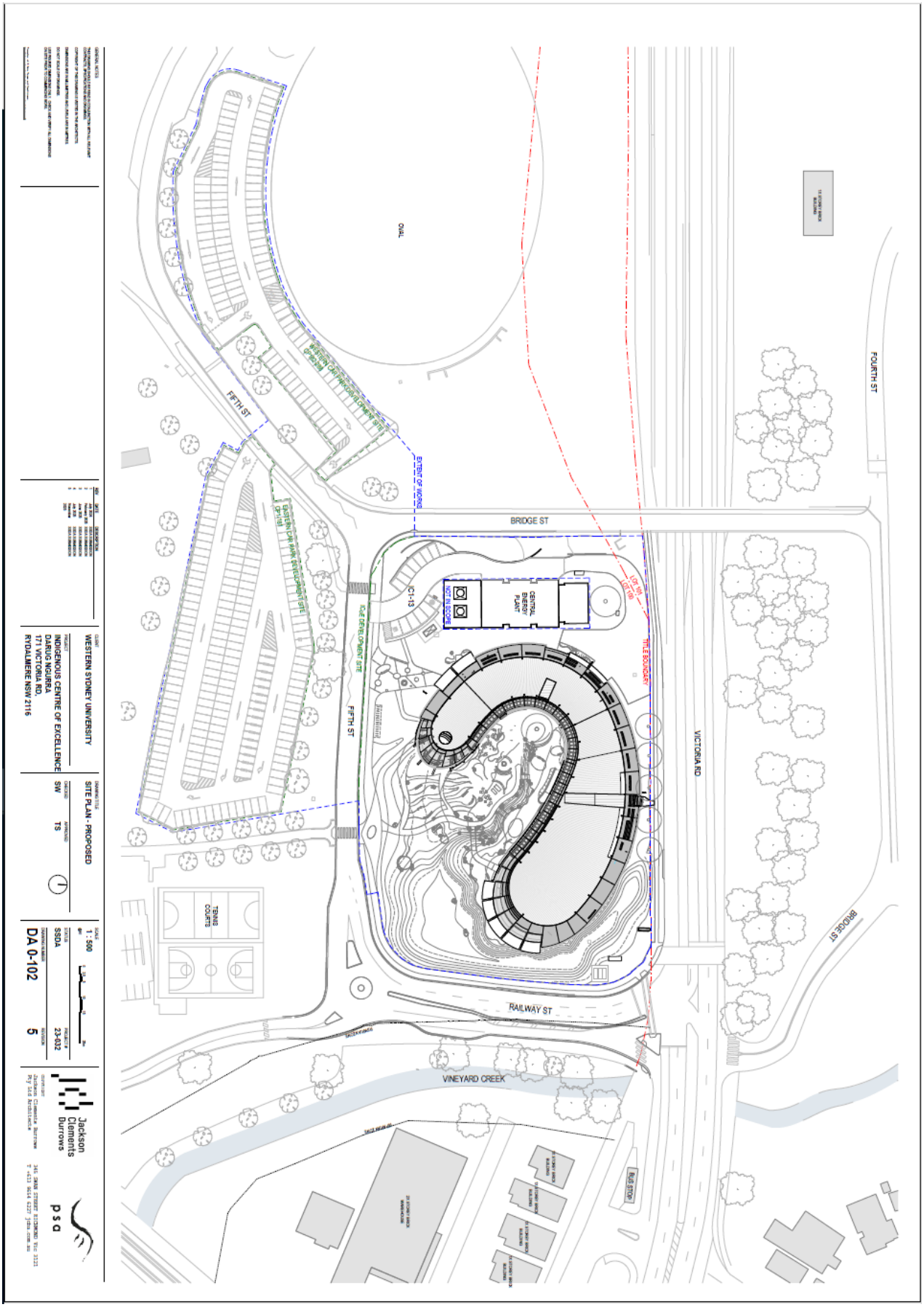
Definitions: (As per NSW Floodplain Development Manual dated April 2005)

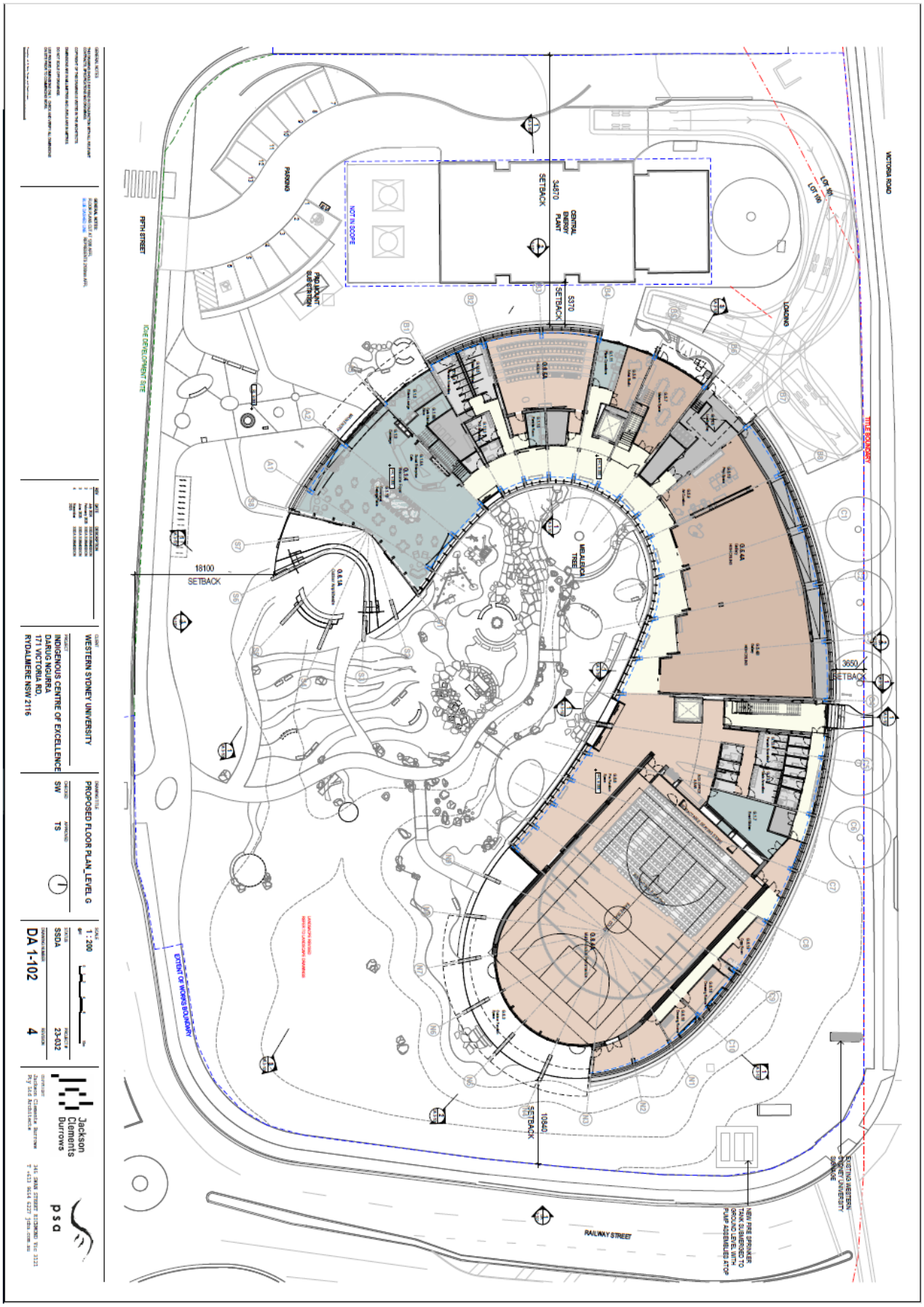
1. **AHD** – a common national surface level datum approximately corresponding to mean sea level.
2. **ARI** – the long term average number of years between the occurrences of a flood as big as or larger than, the selected event.
3. **PMF** – is the largest flood that could conceivably occur at a particular location, usually estimated from probable maximum precipitation.
4. **AEP** – Annual Exceedance Probability is the chance of a flood of a given or larger size occurring in any one year, usually expressed as a percentage.

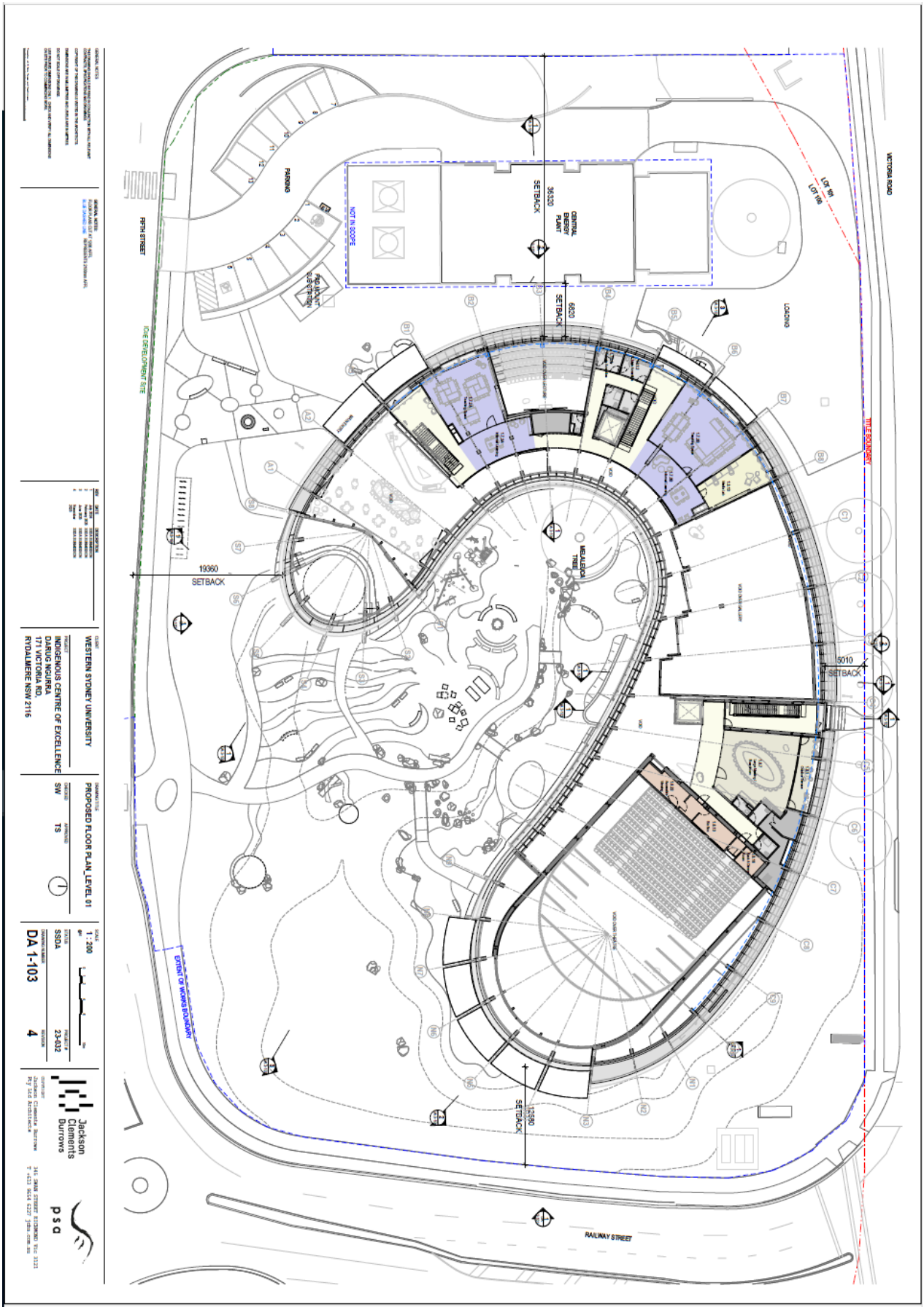

Flood Level (metre AHD)
Chainage
5% AEP
1% AEP
PMF
2333 8.05 8.57 10.51
2350 7.92 8.45 10.48
2378 7.66 8.01 9.97
2500 7.56 7.97 9.90
Ch 2575 8.74 8.96 -
2578 7.24 7.62 9.68
2588 7.02 7.12 8.49
Ch 2637 8.21 8.5 -
2694 7.05 7.15 8.49
2790 7.04 7.14 8.49
Ch 2790 7.48 7.92 -
2740 4.75 4.99 8.49
Ch 2782 7.24 7.77 -
Ch 2818 6.67 7.04 -
2868 4.06 4.65 8.48
Ch 2895 6.5 6.89 -
2908 4.07 4.66 8.48
2916 4.05 4.65 8.48
2930 4.05 4.65 8.48
3000 4.04 4.64 8.48
Ch 3008 6.38 6.77 -
Ch 3040 4.67 5.05 -
Ch 3200 4.18 4.73 -
Ch3208 4.07 4.66 -
4218 4.26 4.88 9.14
4243 4.21 4.83 9.06
4268 4.14 4.75 8.99
4452 4.09 4.70 8.99
4559 4.04 4.65 8.89
4572 4.04 4.64 8.40
4594 4.01 4.61 8.33
4634 4.04 4.64 8.48
Legend
Ground Contour (metre AHD)
Stormwater Pit
Stormwater Pipe
Vineyard Creek Cross Section
Lower Parramatta River Cross Section
Subiaco Creek Cross Section
5% AEP Flood
1% AEP Flood
PMF
Grey Area
NOTE: The Lower Parramatta River Floodplain Risk Management Study - Flood Study Review, the Vineyard Creek Sub-Catchment Management Plan and the Subiaco Creek Sub-Catchment Management Plan are being updated by the Parramatta River Flood Study for which the Final Draft Report is currently on public exhibition. The information indicated on this map may change subject to final completion of the update and adoption of the Flood Study by Council.
City of Parramatta Council Flood Map
DISCLAIMER: Flood levels and flood extent lines are based on current information held by Council. Council does not accept responsibility for the accuracy of this Information. Any pipe sizes and location of pits and pipe lines should be confirmed by site investigation.
The flood levels provided are only an approximate guide and have been derived using the current computer simulated model.
The information provided on this document is presented in good faith. It is the responsibility of each individual using this information to undertake their own checks and confirm this information prior to its use.
City of Parramatta Council, its agents and employees are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement, or advice referred to above.
Printed 12/10/2023
1:6,000
N
Page 3 of 4

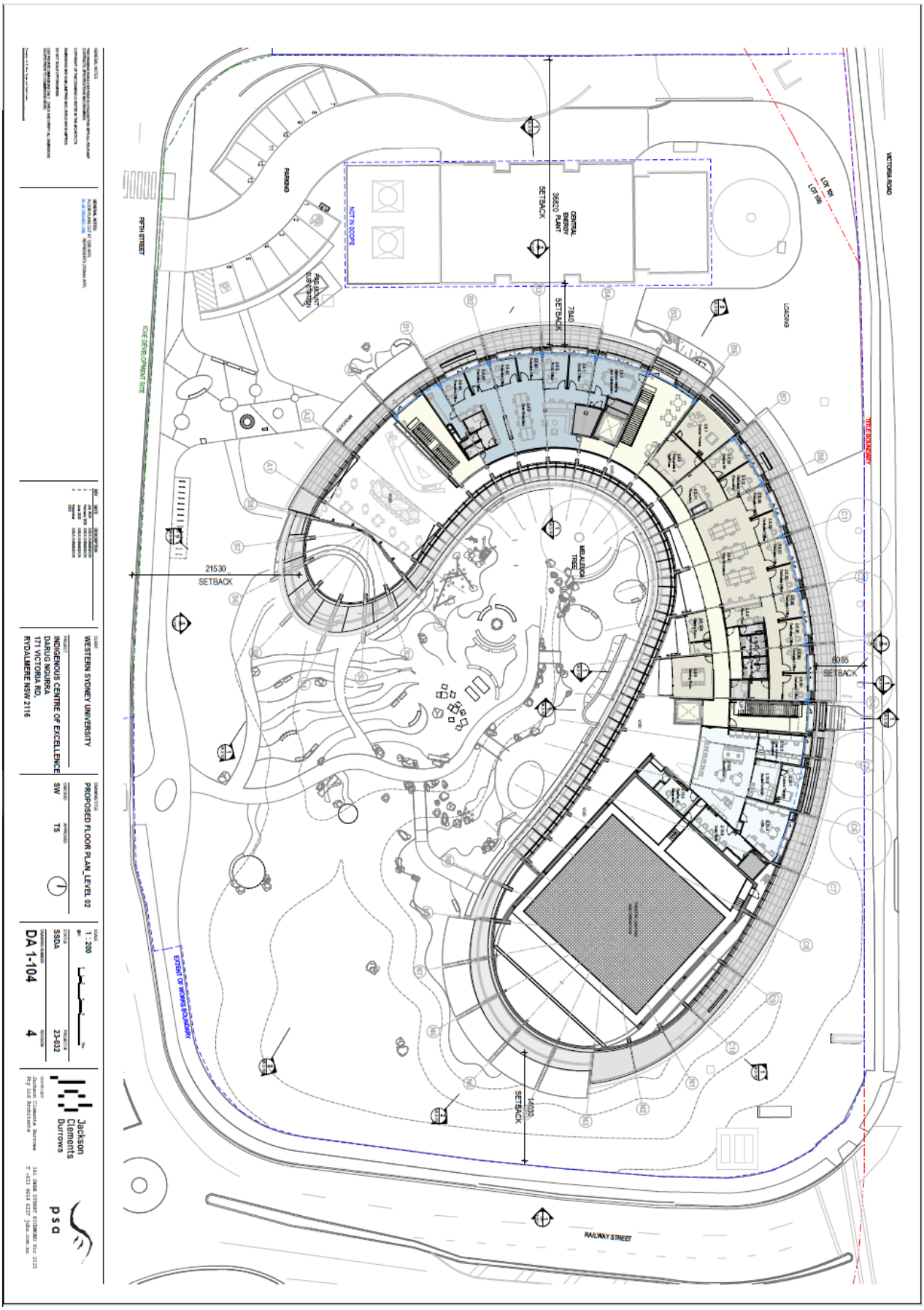

NOTE: Hydraulic hazard extents for Vineyard Creek not shown.
The Lower Parramatta River Floodplain Risk Management Study – Flood Study Review, the Vineyard Creek Sub-Catchment Management Plan and the Subiaco Creek Sub-Catchment Management Plan are being updated by the Parramatta River Flood Study for which the Final Draft Report is currently on public exhibition. The information indicated on this map may change subject to final completion of the update and adoption of the Flood Study by Council.
The abovementioned update will include hydraulic hazard extents for Vineyard Creek.
Legend
Ground Contour (metre AHD)
Stormwater Pit
Stormwater Pipe
Vineyard Creek Cross Section
Lower Parramatta River Cross Section
Subiaco Creek Cross Section
High Hazard-1% AEP
Low Hazard-1% AEP
Low Hazard
Grey Area
Macarthur Street
Gore Street
Morton Street
Grandview Street
Pemberton Street
Pemberton Lane
Victoria Road
Pennant Street
Cobbett Parade
Harley Street
Alfred Street
Oak Street
Hassall Street
George Street
River Road W
Thomas Street
Tennyson Street
James Ruse Drive
Grand Avenue
Third Street
Fourth Street
East Street
Second Street
First Street
Brodie Street
Mary Parade
Rippon Avenue
Dudley Street
Crowley Street
Clyde Street
Euston Street
South Street
Adeline Street
Joseph Street
Calder Road
Bridge Street
Church Street
Printed 12/10/2023
City of Parramatta Council Hydraulic Hazard Map
DISCLAIMER: Flood levels and flood extent lines are based on current information held by Council. Council does not accept responsibility for the accuracy of this Information. Any pipe sizes and location of pits and pipe lines should be confirmed by site investigation.
The flood levels provided are only an approximate guide and have been derived using the current computer simulated model.
The information provided on this document is presented in good faith. It is the responsibility of each individual using this information to undertake their own checks and confirm this information prior to its use.
City of Parramatta Council, its agents and employees are not liable (whether by reason of negligence, lack of care or otherwise) to any person for any damage or loss whatsoever which has occurred or may occur in relation to that person taking or not taking (as the case may be) action in respect of any representation, statement, or advice referred to above.
1:6,000
N

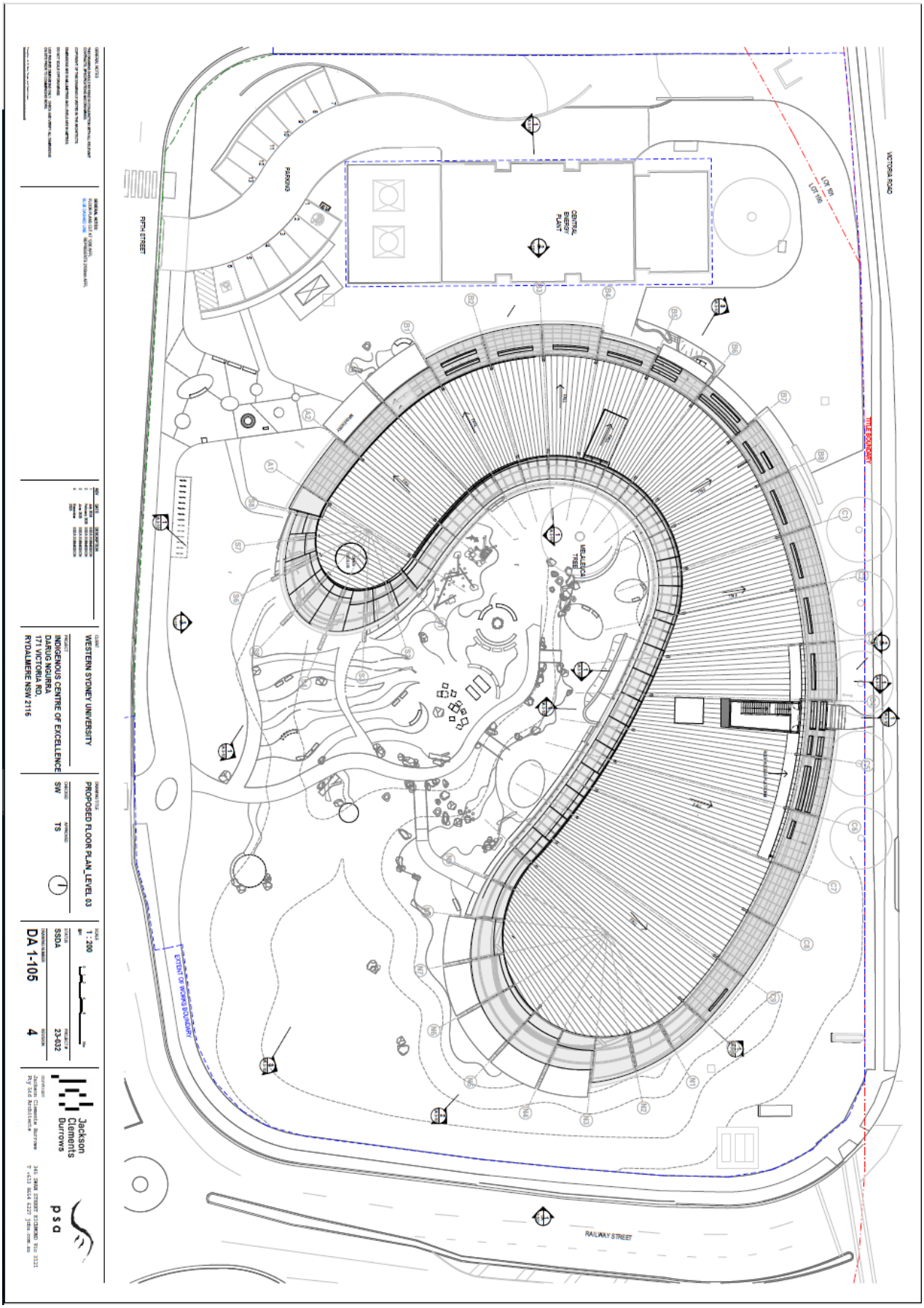
Appendix B: ICoE Architectural Drawings

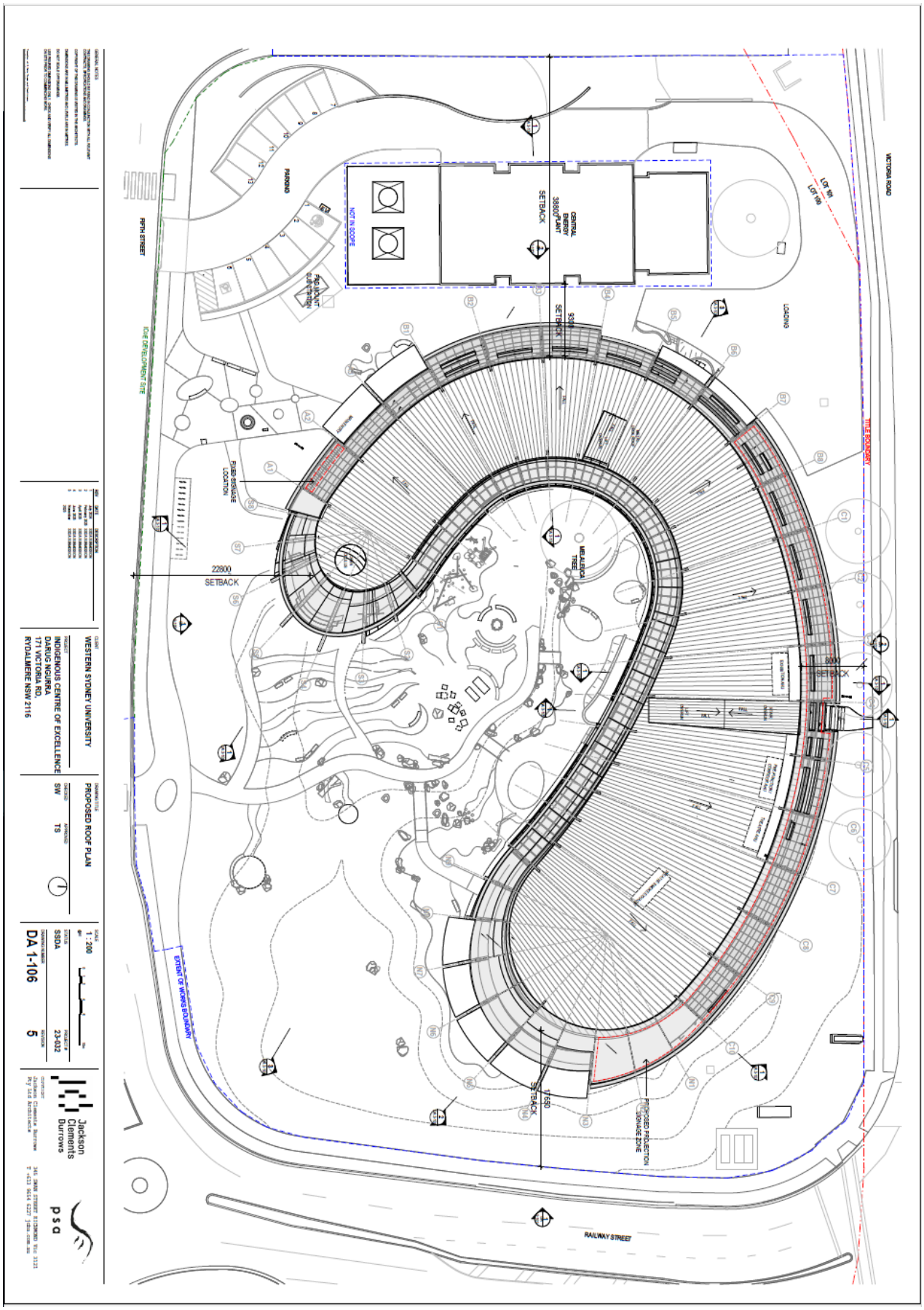

OVAL
FOURTH ST
FIFTH ST
BRIDGE ST
EXTENT OF WORKS
CENTRAL ENERGY PLANT
ICT-13
TITLE BOUNDARY
VICTORIA RD
RAILWAY ST
VINEYARD CREEK
TENNIS COURTS
BUS STOP
WESTERN CAR PARK/LAND OPEN SITE
EASTERN CAR PARK EXTENSION SITE
ICE DEVELOPMENT SITE
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
SITE PLAN - PROPOSED
SW
TS
1:500
SSDA
23-032
DA 0-102
5
Jackson Clements Burrows
psq


PROPOSED FLOOR PLAN_LEVEL G
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
DA 1-102
4
1 : 200
SSDA
23-032
Jackson Clements Burrows
psa
VICTORIA ROAD
FIFTH STREET
RAILWAY STREET
PARKING
LOADING
CENTRAL ENERGY PLANT
NOT IN SCOPE
PAD MOUNT SUB STATION
IDGE DEVELOPMENT SITE
TITLE BOUNDARY
EXTENT OF WORKS BOUNDARY
MELALEUCA TREE
18100 SETBACK
5370 SETBACK
34870 SETBACK
3650 SETBACK
10940 SETBACK
LOT 101 LOT 100
EXISTING WESTERN SYDNEY UNIVERSITY GARAGE
NEW FIRE SPRINKLER TANK SUBSERVICED TO GROUND FLOOR FIRE PUMP ASSEMBLIES ATOP

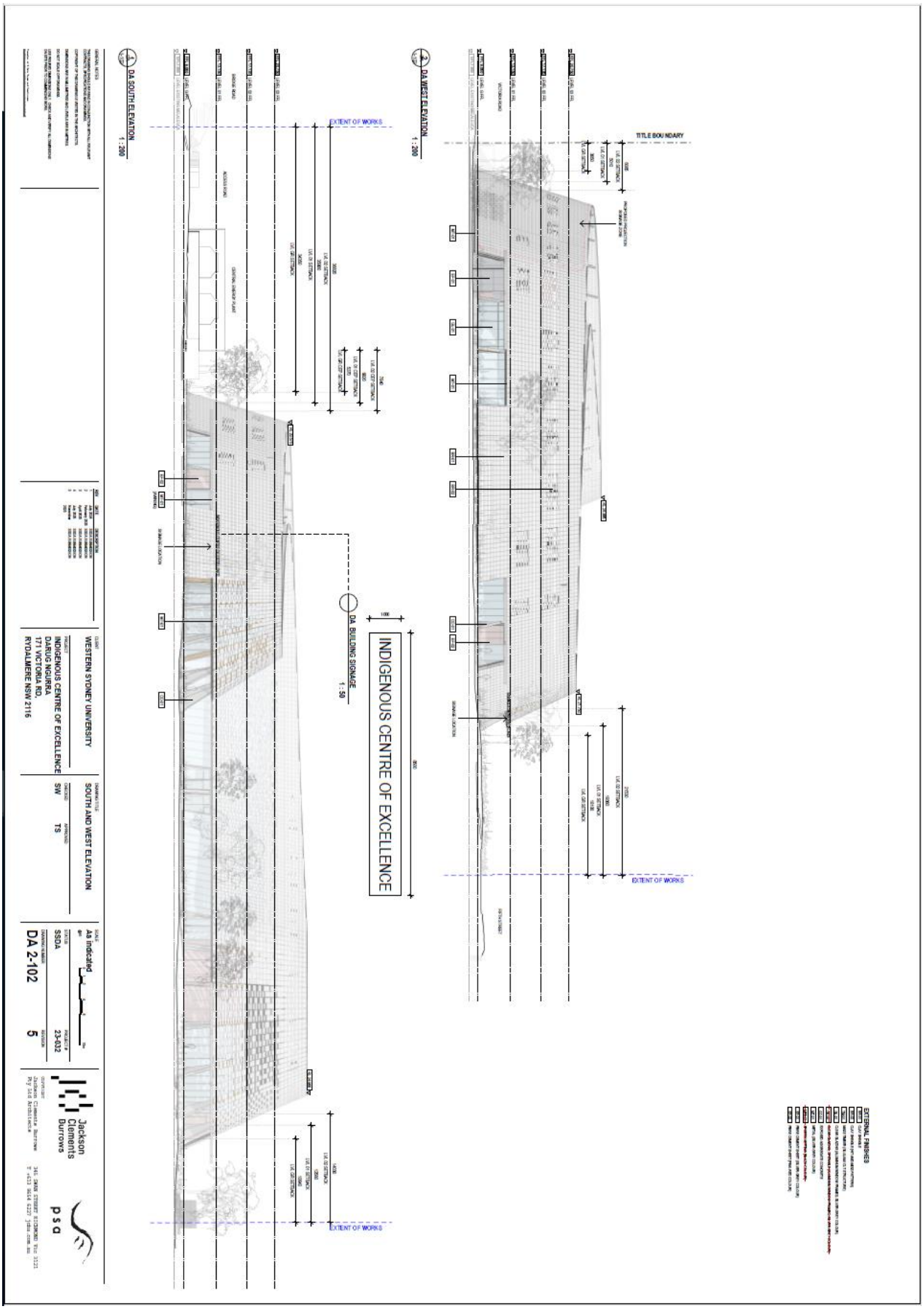

PROPOSED FLOOR PLAN_LEVEL 01
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
DA 1-103
1 : 200
SSDA
23-032
SW
TS
Jackson Clements Burrows
psa
VICTORIA ROAD
RAILWAY STREET
FIFTH STREET
PARKING
LOADING
CENTRAL ENERGY PLANT
NOT IN SCOPE
SETBACK
19360
5010
12580
5920
36320
MELALEUCA TREE
EXTENT OF WORKS BOUNDARY
TITLE BOUNDARY
IDRE DEVELOPMENT SITE


PROPOSED FLOOR PLAN_LEVEL 02
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
DA 1-104
SSDA
1 : 200
23-032
Jackson Clements Burrows
psa
VICTORIA ROAD
FIFTH STREET
RAILWAY STREET
PARKING
LOADING
NOT IN SCOPE
CENTRAL ENERGY PLANT
3580
SETBACK
7840
SETBACK
21530
SETBACK
6065
SETBACK
14030
SETBACK
MELALEUCA TREE
TITLE BOUNDARY
EXTENT OF WORKS BOUNDARY
ICHE DEVELOPMENT SITE


PROPOSED FLOOR PLAN_LEVEL 03
DA 1-105
1 : 200
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
Jackson Clements Burrows
psa
VICTORIA ROAD
RAILWAY STREET
FIFTH STREET
PARKING
CENTRAL ENERGY PLANT
MELALEUCA TREE
TITLE BOUNDARY
EXTENT OF WORKS BOUNDARY


PROPOSED ROOF PLAN
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
DA 1-106
5
1 : 200
SSDA
23-032
Jackson Clements Burrows
psa
VICTORIA ROAD
FIFTH STREET
RAILWAY STREET
PARKING
LOADING
NOT IN SCOPE
CENTRAL ENERGY PLANT
3880
SETBACK
9300
SETBACK
22800
SETBACK
5000
SETBACK
17650
SETBACK
MELALEUCA TREE
PROPOSED PROJECTION SIGNAGE ZONE
EXTENT OF WORKS BOUNDARY
TITLE BOUNDARY
LOT 101
LOT 100

DA EAST ELEVATION
1 : 200
EXTENT OF WORKS
TITLE BOUNDARY
DA NORTH ELEVATION
1 : 200
EXTENT OF WORKS
EXTERNAL FINISHES
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
NORTH AND EAST ELEVATION
1 : 200
SSDA
DA 2-101
5
23-032
Jackson Clements Burrows
psq


DA SOUTH ELEVATION
1 : 200
DA WEST ELEVATION
1 : 200
EXTENT OF WORKS
TITLE BOUNDARY
DA BUILDING SIGNAGE
1 : 50
INDIGENOUS CENTRE OF EXCELLENCE
EXTERNAL FINISHES
WESTERN SYDNEY UNIVERSITY
INDIGENOUS CENTRE OF EXCELLENCE
DARUG NGURRA
171 VICTORIA RD,
RYDALMERE NSW 2116
SOUTH AND WEST ELEVATION
DA 2-102
5
Jackson Clements Burrows
psa

Appendix C: Consideration of the Flood Risk Management Manual (2023)

Responding to the Flood Risk Management Manual 2023

The Department of Planning, Housing and Infrastructure has requested that GRC reference and address the relevant provisions of the Flood Risk Management Manual 2023 for this development.

This manual is primarily targeted at the government and policy development level. As identified in Section 1.2 of the manual:

> *"**The manual does not outline the requirements for the development of flood prone land**. These requirements are provided by the relevant planning legislation and policies, however, in managing development of flood prone land, planning proposal and development consent authorities are to consider the principles of this manual and the advice provided by it and the supporting toolkit."*

GRC has attempted to extract criteria and provisions that may be relevant to this individual development. These provisions, and GRC's response to them, are documented in the table below.

Section	Criteria	GRC Response
2 Principle 1	Establish sustainable governance arrangements	This principle is directed at the government level and is not relevant to this standalone development.
2 Principle 2	Think and plan strategically	This principle is directed at the government level. GRC has modelled flood behaviour at the site in the existing and post-development case in accordance with best practice.
2 Principle 3	Be consultative	This principle is directed at the government level. GRC has reached out for coordination with the City of Parramatta regarding flooding throughout this project.
2 Principle 4	Make flood information available	GRC was unable to obtain a flood model from Council throughout this study. As such, GRC developed a flood model for the site. The flood information that has resulted from this work has been documented in this report.
2 Principle 5	Understand flood behaviour and constraints.	Modelling has been undertaken to develop an understanding of the existing flood affectation at the site.
2 Principle 6	Understand flood risk and how it may change	Flood affectation has been modelled under a variety of design events (including climate change specific scenarios) and development scenarios.
2 Principle 7	Consider variability and uncertainty	A variety of design events of increasing magnitudes and probabilities (including climate change specific scenarios) have been modelled in an existing and post-developed case in order to understand how flooding at the site can vary when subjected to different events.
2 Principle 8	Maintain natural flood functions	The impact of the proposed development has been assessed and amended throughout the course of this project in order to preserve the existing flood function as far as is practicable. The natural flood functions have been maintained.
2 Principle 9	Manage flood risk effectively	A FERP has been developed for the site which documents a suite of recommendations and processes so that occupants and staff can safely prepare and act in the event of flooding at the site.

Section	Criteria	GRC Response
2 Principle 10	Continually improve management of flood risk	A FERP has been created for the proposed development. This plan will improve the management of flood risk at this site.
3	Flood Risk	GRC has conducted flood modelling at this site for the existing and post-development scenario and has assessed the potential flood hazard surrounding the development. A FERP has been developed to help the future occupants manage flood risks and coordinate with the SES to prepare for, and act in accordance with during flood events. This FERP has devised a process for dealing with potential flood risks given the local flooding context and the available warning mechanisms in the local catchment.
4	Managing of Flood Risk	GRC has conducted flood modelling at this site for the existing and post-development scenario and has assessed the potential flood hazard surrounding the development. A FERP has been developed to help the future occupants manage flood risks and coordinate with the SES to prepare for, and act in accordance with during flood events. This FERP has devised a process for dealing with potential flood risks given the local flooding context and the available warning mechanisms in the local catchment.
5	Roles and Responsibilities 5.4.13 Developers *Development proponents may be required by consent authorities to provide information and prepare reports on the impacts of the development on flood behaviour and the existing community, as well as the risks associated with the development and its use. These reports should identify management measures needed to address these risks. Proposed management measures to offset impacts may require development approval and may be subject to additional approval requirements. Developers may also be required to contribute to the costs of management measures required to limit the effects of their development on others.*	GRC has prepared this report for the proponent regarding this development. The report includes: • the impacts of the development on flood behaviour and the existing community, as well as the risks associated with the development and its use (see FERP). • The design of the development has been informed by flood modelling and an iterative process has been undertaken to preserve existing flood behaviour and limit the exposure of occupants to potential flood risks. • A FERP has been developed to guide management measures for flood preparation and procedures to be enacted during flood events.